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THE TREATMENT OF CLAW-FOOT *

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The subject of claw-foot (pes cavus, hollow-foot, etc.) has been so well covered in the literature, especially during the last twenty years, that it is unnecessary and, of course, impossible to review the condition in detail. The object of this paper is merely to outline those features which seem of major importance, and to discuss from personal experience one system of treatment which seems to be fairly satisfactory although in no way new.

A definition of claw-foot is difficult, as the various contributions and attempted classifications show, but the so-called idiopathic type appears to be the true form. Although frequently the underlying cause is evident, there seems to be no reason for subdividing the cases, unless one desires to say that certain of them are congenital in cause and the rest acquired. The deformity is largely, if not entirely, one of the forefoot which has dropped,—usually because of an ill-defined weakness of some of the muscle groups—with resulting cavus deformity (Fig. 1). Secondary to this, there is the typical contracture of the toes which, except in long-standing, severe cases, disappears when the cavus is obliterated. This is demonstrated in the milder cases when pressure under the ball of the foot flattens out the arch. All grades of cavus are seen, ranging from those of such slight degree that a distinction between a deformed foot and a simple high arch is difficult, to those advanced cases where there are large callosities or even ulcers under the heads of the metatarsals, marked cocking of the toes with dislocation at the metatarsophalangeal joints, and an excessive degree of cavus with extreme contracture of the plantar structures. In the mild or early cases the cavus disappears when the weight is put on the foot or when, as mentioned above, pressure with the hand is placed under the heads of the metatarsals. In others the deformity becomes more fixed, and the heightened arch and the cocked

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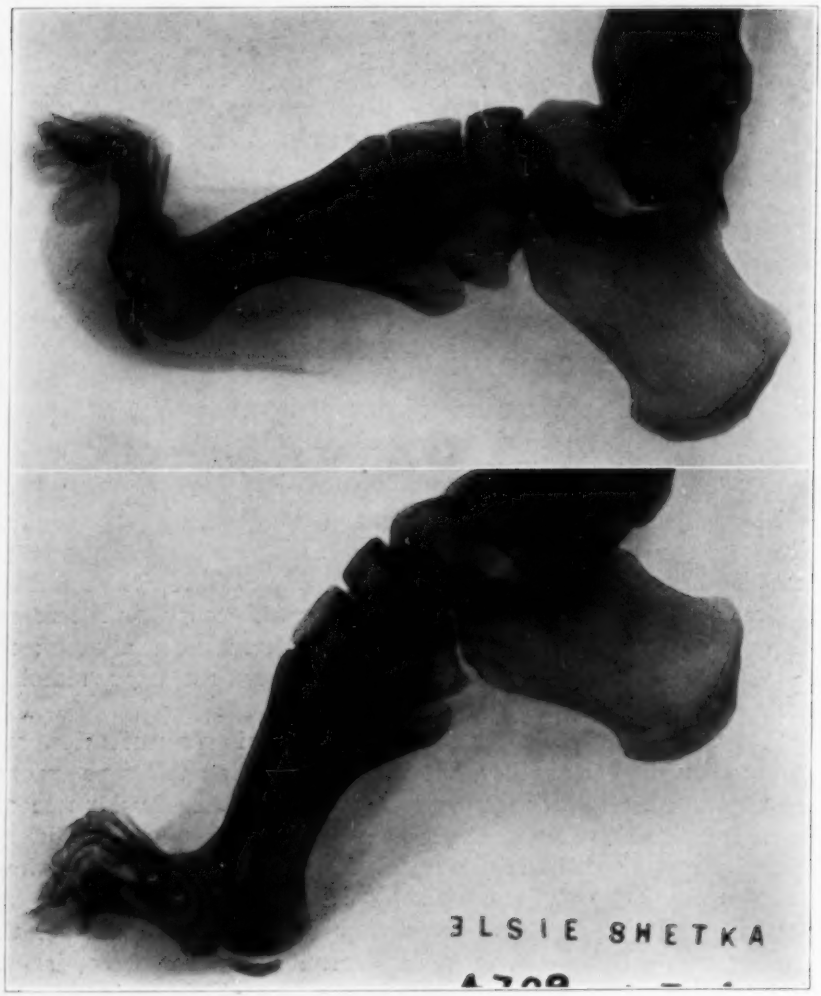

FIG. 1

Claw-foot in extreme of dorsal flexion and plantar flexion, showing that deformity is anterior only, and that there is no contracture posteriorly.

toes do not disappear on weight-bearing. Because of this, as growth takes place, the individual bones in the foot become intrinsically deformed and a true bony cavus is present which varies in degree with the individual case. Although many cases tend to progress, we find stationary cases of all grades, and the better results, following any but the most radical treatment, are probably in this group.

Etiologically we know that the deformity of claw-foot can be due to several underlying causes, but that apparently all of these result in some weakness or interference with the function of certain muscles in the foot. The central nervous system is, therefore, the site of the underlying pathology in most cases, and certainly spina bifida occulta is one of the

FIG. 2
Insole with anterior arch bar.

main factors in many individuals, although infantile paralysis claims a fair number of cases. The rarer factors are certain myelodysplasias, Friedreich's ataxia, multiple sclerosis, progressive muscular dystrophies, etc.

The mechanism of this deformity, why the forefoot drops and the plantar structures become contracted, has been discussed and explained by many authors, but never to the complete satisfaction of all surgeons, although there is probably some grain of truth in all of the theories. This ignorance of the exact mechanism which is called into play to cause a cavus emphasizes the need for further studies, and makes the deformity one of peculiar interest to many of us. Weakness of the interossei, lumbricales, and other intrinsic muscles of the foot has been the usual explanation, but there are anatomical reasons why this cannot be entirely accepted. It would seem that weakness of the tibialis anterior muscle, without involvement of the toe extensors, might have some bearing on the formation of the deformity, and certainly a strongly pulling or poorly opposed peroneus longus muscle can accentuate the cavus.

FIG. 3
Night splint with anterior arch bar.

It is apparent, therefore, from all that has been said, that, in itself, a claw-foot is not an entity, but merely a symptom of an underlying condition. The deformity, of course, is frequently the only recognizable symptom present.

Regardless of underlying causes, with some apparent exceptions, of course, the deformity, in whatever stage we see it, needs treatment if disability is present. We must remember, however, that many individuals, with the milder degrees of cavus, go through life with little trouble other than the use of extra caution in the fitting of their shoes. Therefore, all cases do not need active or radical care. It is when the contractures are such

that the feet become painful, and callosities develop under the heads of the metatarsals and over the contracted toes, that real crippling occurs. It should be our aim to prevent, if possible, such crippling by well directed early treatment. The object of ideal treatment is, of course, to correct the cavus and prevent its recurrence. Any method used must at least work toward these ends with the realization that complete attainment is probably never possible. Treatment in most cases is started in childhood or early adolescence.

The following procedures, all of which are familiar to you, are reviewed in order to show their adherence to the above principles, and the systematic way in which they can be utilized in the treatment of claw-foot from the mild to the very severe types.

It is evident that if, in the early or mild stage of deformity, the permanent contracture of the plantar structures can be prevented, the cavus, with the accompanying clawing of the toes, can be kept to a minimum. Although efforts along this line are not always successful they should be given a fair trial.

The routine used is as follows: daily repeated manipulations with flattening of the arch and stretching of the plantar structures; exercises to strengthen the dorsiflexors of the foot without allowing cocking of the toes; the use of an anterior arch bar in the shoe or, better yet, an insole with an anterior bar incorporated in it (Fig. 2); the use of a night splint, which also has a bar, to bring pressure back of the metatarsal heads and thus counteract the cavus-forming forces (Fig. 3).

In more advanced cases where the clawing is already fixed but where the deformity is not severe, treatment of a more radical nature, which

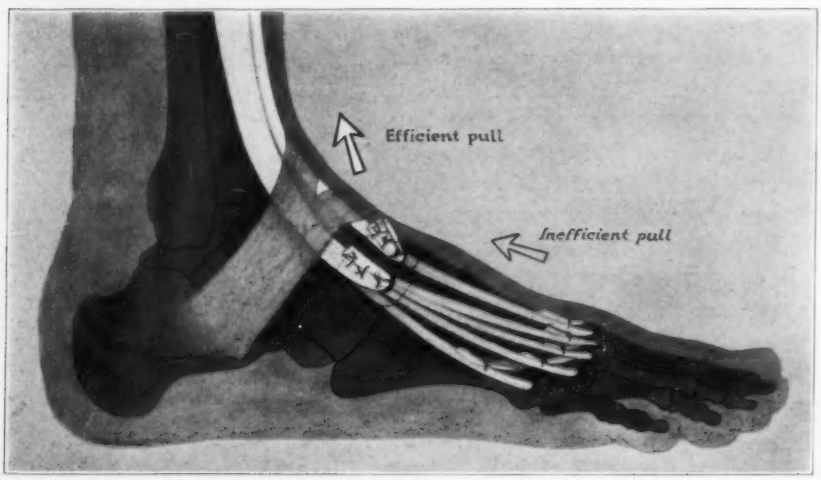

FIG. 4

Diagram shows how the transplanted extensors of the toes act to the greatest advantage as dorsiflexors of the foot when placed into the cuneiform bones. The loss of power and inefficiency of the pull when the tendons lie parallel to the metatarsals after transplantation to the metatarsal heads are obvious.

must first be directed toward correction of the deformity, is needed.

The procedures used to accomplish this are two in number: (1) In the simpler cases a subcutaneous plantar fasciotomy with wrenching of the foot is sufficient. (2) More resistant cases need complete freeing of the plantar structures by the os calcis stripping operation of Steindler.

A plaster-of-Paris dressing is applied after either of these operations with the foot held as flat as possible, but with great care taken that the heads of the first and fifth metatarsal bones are under no undue pressure. After three weeks the plaster can be removed, physiotherapy started, and the routine described in the mildest cases followed.

A few cases seem to need nothing more than this, but in the majority some operation is needed to prevent the recurrence of the deformity—our second principle of treatment—as, of course, the causative factors usually are still acting. For this the modified procedure of Hibbs is used.

In brief, this consists in transplanting the tendon of the extensor hallucis longus muscle and the four tendons of the extensor digitorum longus muscle proximally into the cuneiform bones, so that their pull will reenforce the tibialis anterior as efficiently as possible in dorsiflexing the ankle. There is no logical reason for transplanting these tendons into the heads or necks of the metatarsals, as has been described by several surgeons, because, in addition to the tediousness of this procedure, there is a loss of power when the tendons lie parallel to the parts they are endeavoring to lift (Fig. 4). The illustrations show the technique of the operation and need little elaboration (Figs. 5, 6, 7, and 8). After removal of the long extensors from the toes, the smaller toes function sufficiently well, but the great toe will drop; therefore, the interphalangeal joint of the hallux must be ar-

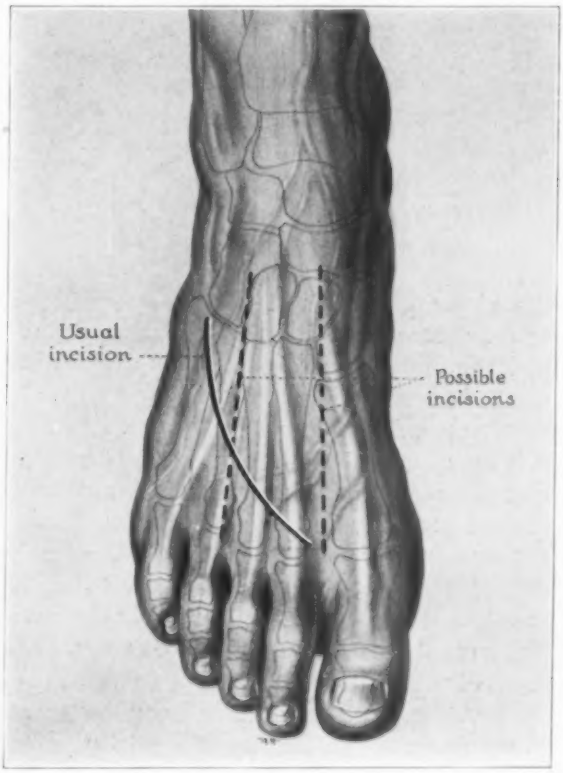

FIG. 5

Modified Hibbs transplantation, showing approximate line of incision. Two longitudinal incisions have also been tried and can be used if desired.

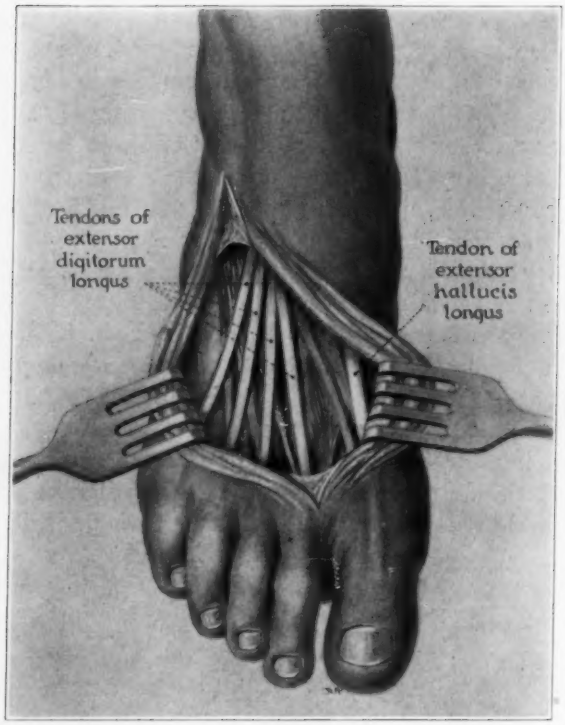

FIG. 6

Incision shown in Fig. 5 retracted to show long extensors of the toes. The vessels and nerves have been omitted for the sake of clearness.

throdesed. A tenodesis of the distal stump of the extensor hallucis longus into the first metatarsal is sometimes used in place of the arthrodesis, but the latter is to be preferred in patients over ten or twelve years of age. The postoperative plaster dressing is removed after six weeks, and active physiotherapy is started. Weight-bearing is allowed in a shoe—previously described—with an anterior heel or its equivalent.

The simple transplantation of the peroneus longus tendon to the insertion of the brevis, as described by Bentzon, may accomplish what we are after in some cases, but, although it appears to be theoretically sound if used in younger individuals with no great intrinsic bone deformity, the author has had no experience with this operation.

If bone deformity of any marked degree is present, the cavus cannot be corrected by releasing the plantar structures and wrenching the foot. It is then that removal of a wedge of bone is indicated as the only possible way of making the foot symptomatically less disabling, and anatomically more normal in appearance. It has never seemed justifiable to the author to remove this dorsal wedge from the neck of the astragalus or to destroy the talonavicular or calcaneocuboid joints, so for many years a so-called anterior-tarsal-wedge osteotomy has been used (Fig. 9). This preserves the lateral motion of the foot, correcting the deformity where it should be corrected, and gives as a result not only a fairly normal-appearing foot, but also one which is functionally excellent. If a wedge of bone which destroys the midtarsal joint is to be removed, a complete arthrodesis should be performed at the same time. It is, however, to prevent this loss of function that the anterior-wedge osteotomy is advocated.

A longitudinal incision is made on the dorsum of the foot and carried down between the tendons to the bone, in much the same way as in the

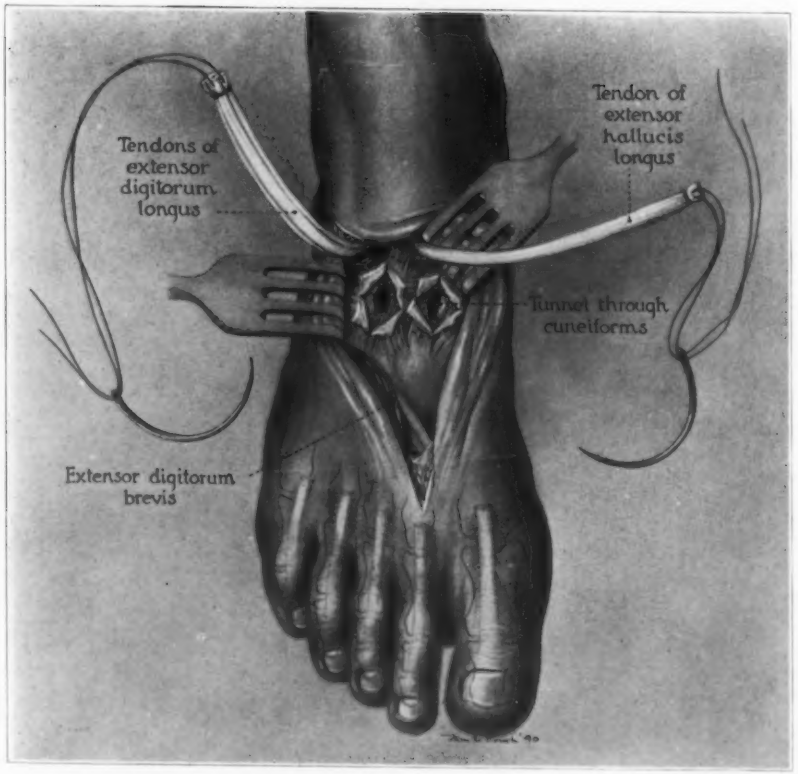
Tendons of extensor digitorum longus
Tendon of extensor hallucis longus
Tunnel through cuneiforms
Extensor digitorum brevis

FIG. 7

The tendons shown in Fig. 6 have been cut and the four slips of the extensor digitorum longus held together in one bundle by a suture of silk or chromic catgut. The tendon of the extensor hallucis longus has a similar suture attached to it. The tunnel in the cuneiform bones has been drilled after the periosteum has been scraped away from the crucial incisions.

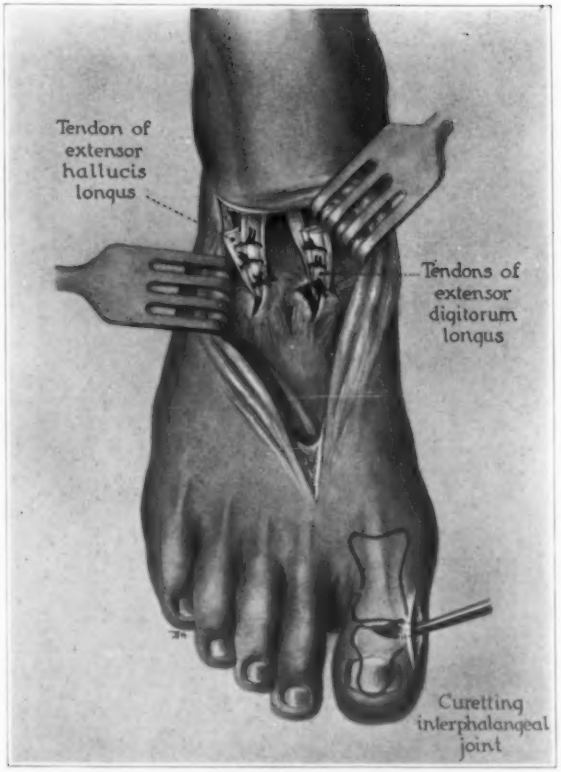

FIG. 8

The tendons shown in Fig. 7 have been passed through the tunnel in the cuneiform bones, the extensor digitorum longus bundle from the lateral to the medial side, and the extensor hallucis longus in the opposite direction. The tendons are held in place by interrupted sutures, the distal one on each side passing through the periosteum. Through a small medial incision the interphalangeal joint of the great toe is curetted in order to initiate ankylosis.

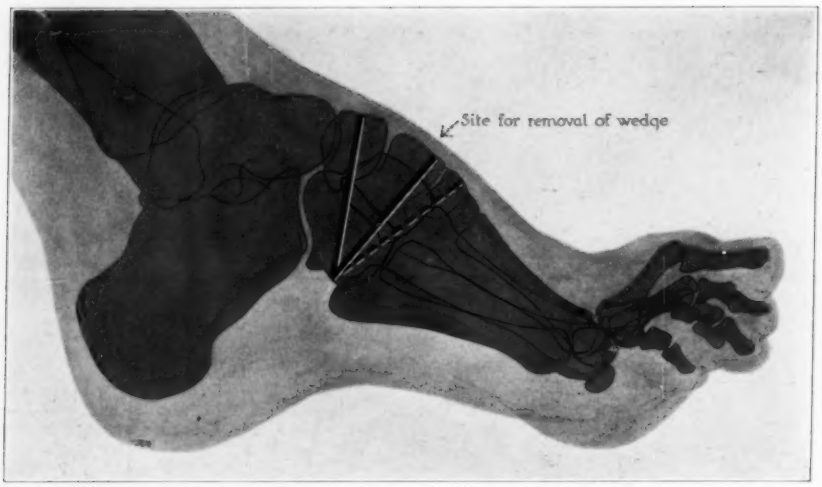

FIG. 9

A diagrammatic representation of the foot to show location of wedge in anterior-tarsal-wedge osteotomy. Note that the proximal cut is anterior to the midtarsal joint.

tendon transplantation described. The anterior tarsal region is then exposed subperiosteally as far as possible, a knife being generally used for this dissection. When the bones have been identified, a nearly vertical osteotomy is made from near the center of the navicular and cuboid bones to the under surface of the tarsus. A second osteotomy, starting anterior to the first and connecting with it at its plantar edge, is then made, the distance from the proximal cut depending on the width of the wedge necessary in the particular case. The forefoot is then brought up out of the dropped position, thus closing the gap made by the removal of the wedge. A few interrupted sutures will close the periosteum and the skin. A plaster-of-Paris dressing is then applied which extends from the toes to just below the knee. This dressing remains on for about eight weeks, when weight-bearing without support can usually be started.

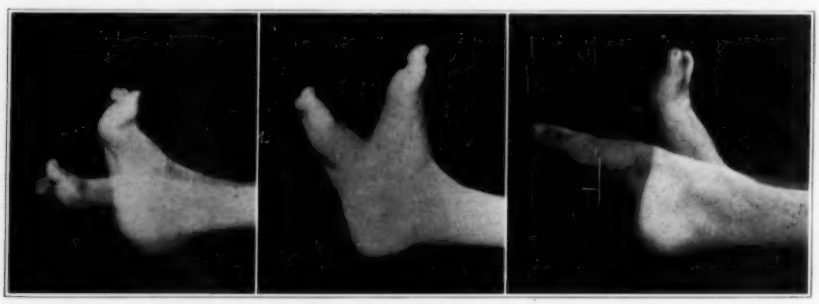

FIG. 10-A FIG. 10-B FIG. 10-C

C. E. Subcutaneous plantar fasciotomy and transplantation of the toe extensors. Fig. 10-A: The foot before operation. Fig. 10-B: Result two and one-half months later. Fig. 10-C: Result three years later.

FIG. 11-A

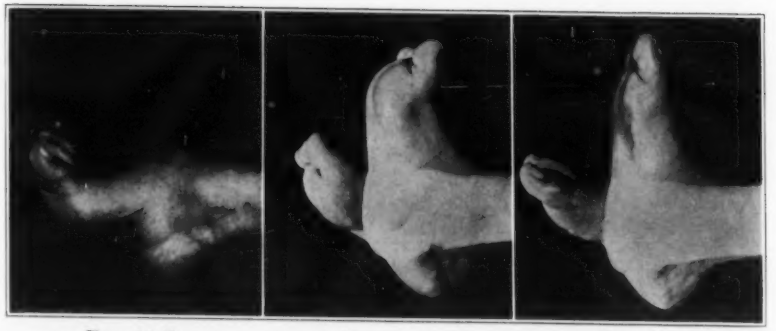

FIG. 11-B FIG. 11-C FIG. 11-D

FIG. 11-E

Fig. 11-A: F. L. X-ray of claw-foot before operation.
Fig. 11-B: Claw-foot before operation.
Fig. 11-C: Same foot after Steindler stripping.
Fig. 11-D: After transplantion of toe extensors.
Fig. 11-E: Roentgenogram after operation.

FIG. 12-A FIG. 12-B

W. S. Claw-foot before operation and three years after transplantation of toe extensors.

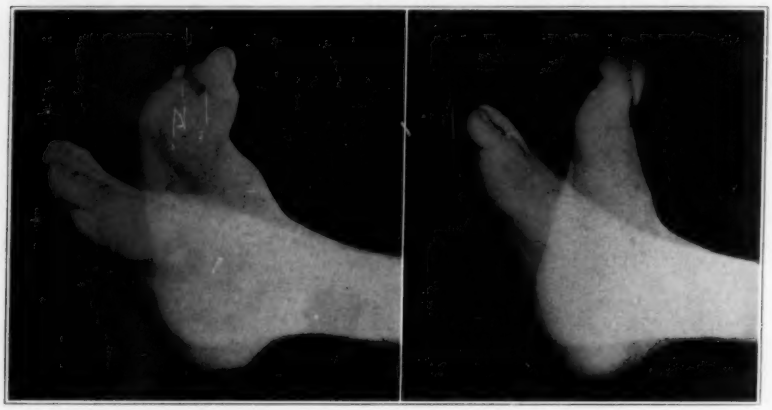

FIG. 13-A FIG. 13-B

R. H. Moderate claw-foot before and after anterior-tarsal-wedge osteotomy.

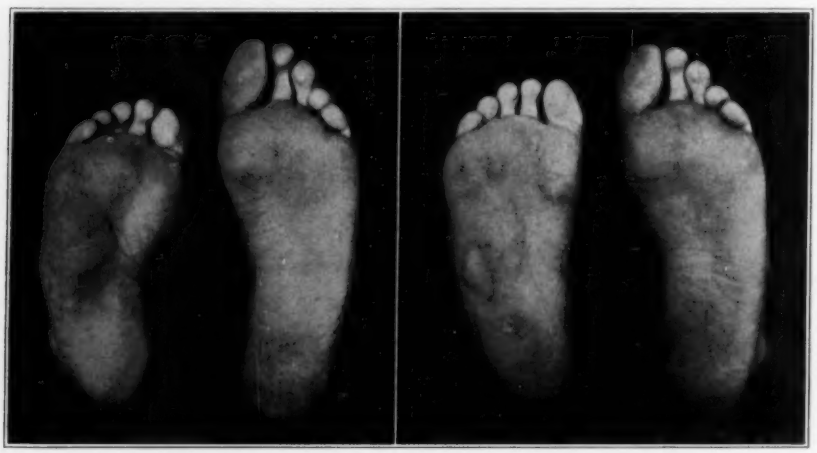

FIG. 13-C FIG. 13-D

R. H. Soles of feet before and after removal of anterior tarsal wedge.

It will be found that with correction of the cavus the toes will straighten out. It is only occasionally that any direct attention need be paid to them, although some hammer toes will have to be taken care

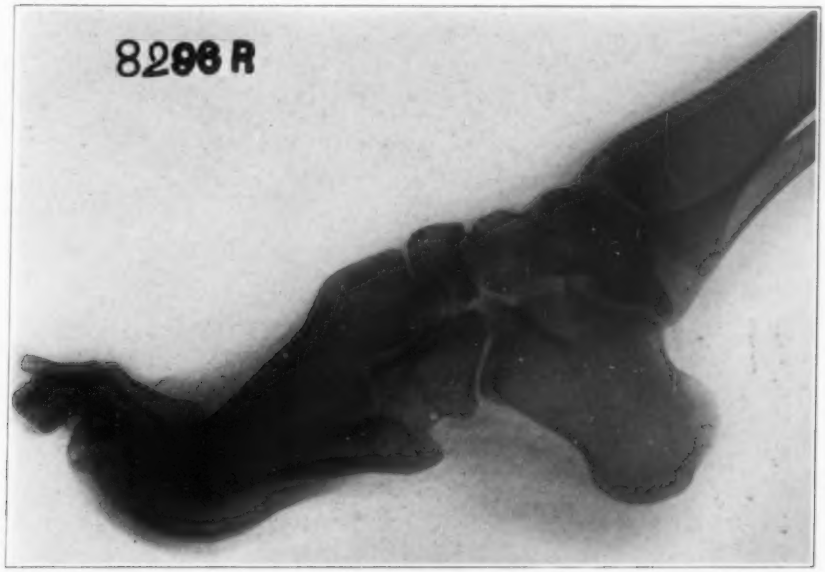

FIG. 14-A

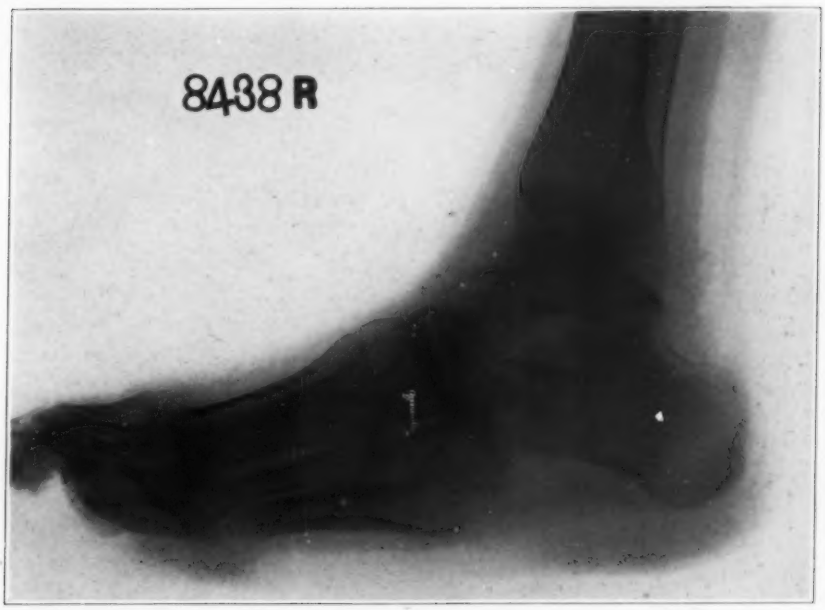

FIG. 14-B

K. T. Roentgenograms of claw-foot before and after plantar fasciotomy and anterior-wedge osteotomy.

of in the older individuals. Callosities disappear when their cause is removed, but at times the use of salicylic-acid preparations will be necessary to hurry the convalescence. The tendon transplantation described may occasionally be indicated after this osteotomy.

FIG. 15-A

N. R. Roentgenogram showing marked bone cavus before operation.

FIG. 15-B

N. R. Roentgenogram after plantar fasciotomy and anterior-wedge osteotomy.

There are some exceptional cases of claw-foot, in addition to those that have been discussed, where a good result can be obtained only by arthrodesis, and one will see very rarely an old neglected case where

FIG. 15-C

N. R. Roentgenogram taken seven years later showing functioning midtarsal joint.

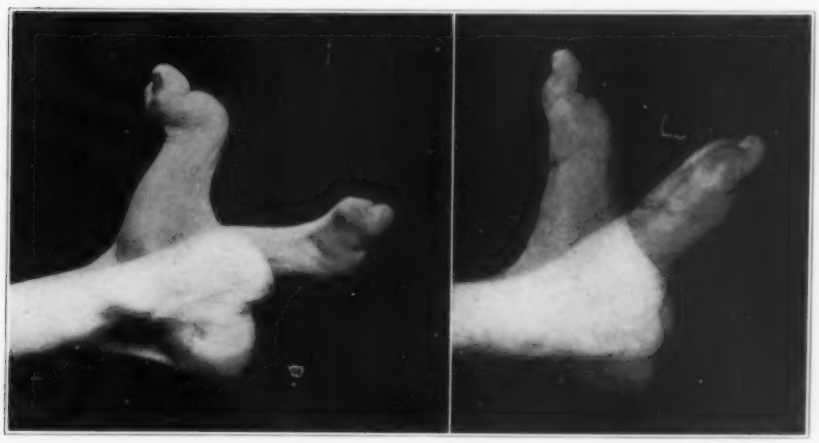

FIG. 16-A FIG. 16-B

C. A. Claw-foot before and after transplantation of the toe extensors.

amputation is the only solution. However, these cases are not common, and the more conservative measures, resulting in the retention of a function which is usually excellent, will be found sufficient in the vast majority of claw feet. A few illustrations will show the effect of the treatment advocated (Figs. 10-A to 16-B).

SUMMARY

1. True claw-foot is due to a lesion of the spinal cord, usually spina bifida occulta or poliomyelitis, with resulting weakness of certain muscles of the foot. It is, therefore, a symptom and not an entity.

2. By systematic treatment some cases at least can be checked and others corrected with good functional feet resulting.

3. Transplantation of the toe extensors to the cuneiform bones will aid in keeping the sole flat and preventing a progressive cavus.

4. When wedge osteotomy is necessary to overcome the cavus, an anterior tarsal wedge will save function, and correct the deformity.

DEFORMITIES OF THE FEMUR RESULTING FROM ARRESTMENT OF GROWTH OF THE CAPITAL AND GREATER TROCHANTERIC EPIPHYSES

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The importance to the clinician of some knowledge of the physiology of bones and of other supporting tissues cannot be overemphasized. This is particularly true for the physician who limits his clinical work to the treatment of conditions which affect these structures. The longitudinal growth of bone occurs from the epiphyseal cartilages. The susceptibility of these growth centers to injury from trauma or disease, producing growth arrest and resulting in shortening of extremities and in deformities, has been adequately stressed by clinical observers and by reports of laboratory experiments (Haas, Speed and Macey, Gatewood and Mullen, Compere, and Siegling).

Occasionally, even an experienced surgeon has carried out and recommended some surgical procedure which endangers the irreplaceable growth cartilages of the bones of growing children.

Bozsan, in 1931, in a case presentation before the Clinical Society of the Hospital for Joint Diseases, recommended multiple drilling as a method of treating fracture of the neck of the femur, slipped femoral epiphysis, and Legg-Calvé-Perthes disease. He described this procedure in *The Journal of Bone and Joint Surgery* for October 1932 and again, in slightly greater detail, in the same publication in January 1934. Later in the same year, Ferguson and Howorth described a similar procedure, which they stated would be indicated for early cases. These authors emphasized the fact that the operation itself was relatively simple and that there were no immediate morbid results, such as death or serious infections. The theory of the operative procedure was to provide channels for hastening the revascularization of the femoral head. In cases of Legg-Calvé-Perthes disease these channels had to be drilled through the epiphyseal-cartilage plate, joining the capital epiphysis to the diaphysis of the neck. The fact that such drilling might result in permanent injury to growth-cartilage cells on the metaphyseal side of the capital or greater trochanteric epiphyses appears to have been overlooked.

In 1935, one of us (Compere) reported a high incidence of growth deformities resulting from fractures which involved the shaft, growth-cartilage plates, and epiphyses of a long bone. Cases have been observed in which surgeons operated well, but not wisely, in performing open re-

* This work was made possible in part by aid from the Douglas Smith Foundation.

ductions of fractures near the growth centers of bones of small children. Some of these operations resulted in growth deformities so severe as to cause permanent disability.

Experiments were undertaken to determine just what deformities could be anticipated as a result of gross trauma to the growth center of the greater trochanter or of the capital epiphysis of the femur.

EXPERIMENTAL METHOD

Twenty-three puppies, approximately six weeks of age, were used in the beginning of the experiment. Most of these animals succumbed to snuffles or other kennel infections. An attempt was made to use young rabbits, but the proximal femoral epiphyses were too small to subject them to multiple drilling.

One or both of the two major growth centers of the proximal end of one femur in each of twenty-seven goats, six weeks of age, were subjected to operative trauma.

Group I: A portion of the cartilage plate between the epiphysis of the greater trochanter and the shaft was curetted and chips of bone were placed in the defect.

Group II: The epiphyseal-cartilage plate of the greater trochanter was drilled from three to six times with a rotary bit, one-sixteenth of an inch in diameter.

Group III: The drill was passed through the neck and into the head of the femur five or six times in various directions, perforating the growth-cartilage plate.

Group IV: A portion of the growth cartilage of the femoral neck was removed by curettage.

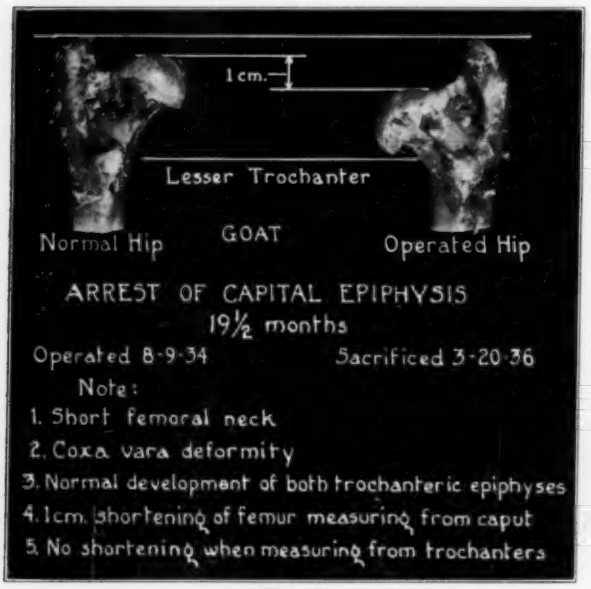

FIG. 1

These goats were sacrificed at various intervals, the longest period being nineteen and one-half months after operation. In most of the animals a weak abductor resulted or a short-leg limp developed and persisted.

Roentgenograms of the femora of the goats were not satisfactory for purposes of measurement or of comparison.

At necropsy each femur, to-

gether with both trochanters, the head, and the neck, was removed and the soft tissue was stripped away. The normal femur and the operated femur of each animal were placed side by side, photographed, and x-rayed. Measurements were also taken from the apex of the head to the most distant portion of the articular surface of the medial condyle of each femur and from the tip of the greater trochanter to the articular surface of the lateral femoral condyle.

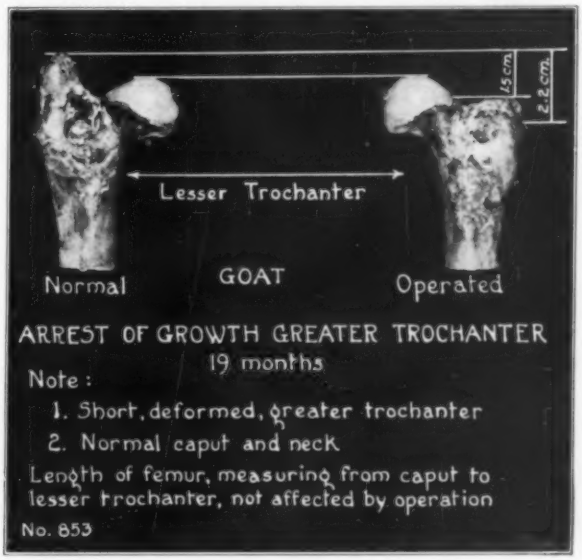

FIG. 2

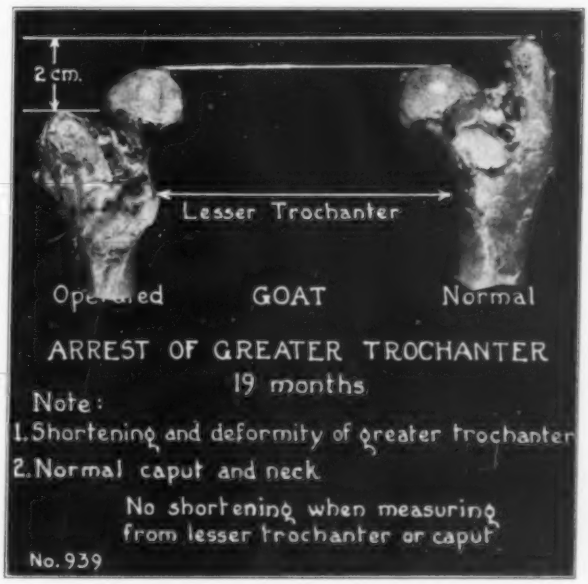

FIG. 3

RESULTS

In this study we are interested primarily in end results from the standpoint of growth, and measurements of the immature animals are not included. Operative trauma, whether from multiple drilling or from curettage of the growth cartilage of either the greater trochanter or the capital epiphysis, resulted in growth arrest from this center. Growth arrest following drilling did not occur as promptly as that which resulted from extensive curettage. The end results were quite comparable. When the goats were sacrificed from eighteen to nineteen months after operation, the operated hips of goats from Groups I and II, in which the growth center of the capital epiphysis had been injured, showed a characteristic deform-

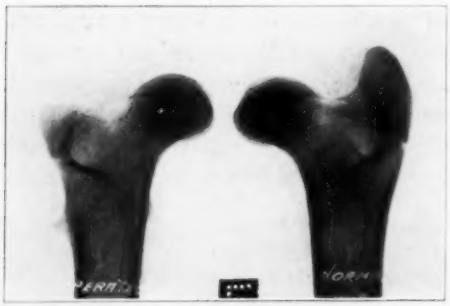

FIG. 4

Roentgenograms of the proximal end of a normal femur of a goat and of a femur eighteen months after multiple drilling through the greater trochanter. The roentgenogram of the operated femur shows the shortened, deformed trochanter. Longitudinal growth of the shaft has continued.

FIG. 5

Roentgenograms of the proximal end of a normal femur of a goat and of a femur eighteen months and nineteen days after multiple drilling of the neck and head. In the operated femur there is deformity, as evidenced by the irregular outline of the head, the short neck, and coxa vara. The trochanter has continued to grow.

ity of short femoral neck, coxa vara, and a trochanter which had grown well beyond the highest point of convexity of the femoral head (Fig. 1). There was an actual shortening of one centimeter.

Nineteen months after surgical trauma to the greater trochanter, this structure was grossly maldeveloped, and there was a definite coxa valga. No shortening of the neck or deformity of the head on the side of the operation was noted (Figs. 2 and 3).

Roentgenograms of the upper ends of the femora of goats, following growth arrest of the greater trochanter, showed the shortened trochanter with coxa valga deformity of the neck (Fig. 4). Roentgenographic changes resulting from traumatic insult to the growth cartilage of the head of the femur included a short neck, irregular contour of the head, and moderate coxa vara deformity (Fig. 5).

Deformity of the shaft of the femur, as well as of the neck, is illustrated in the print of roentgenograms of the specimens obtained from Goat 947, nineteen months after operation (Fig. 6). The growth of the greater trochanter had been incompletely arrested on one side. This had resulted in coxa valga deformity, rotation of the shaft proximally, and an increase in the anterior femoral bow. Because of continued growth of the capital epiphysis, together with the coxa valga, the length of the femur was slightly greater than that of the unoperated leg.

The average length of the femora of the young goats (aged six to seven weeks) was ten and six-tenths centimeters. The average length of the normal femora of the adult goats (aged nineteen months) was nineteen and six-tenths centimeters. Length growth of the femora from the age of seven weeks to physical maturity was nine centimeters. The loss in length (greater trochanter to articular surface of the lateral condyle) which resulted from fusion of the epiphysis of the greater trochanter to the

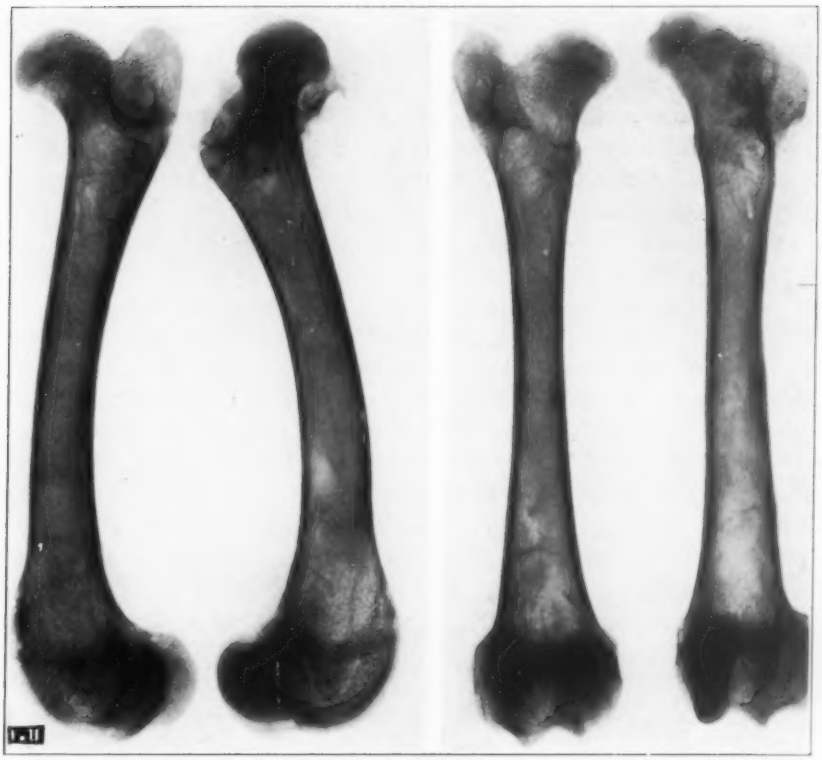

FIG. 6

Roentgenograms of the full length of the shafts of both femora of a goat nineteen months after multiple drilling of one greater trochanter. This illustrates the coxa valga, the deformity of the greater trochanter, and the moderate torsion of the proximal end of the femur. Approximately two millimeters of greater length of the femur of the operated side may be explained on the basis of the coxa valga. A question of possible growth stimulation, resulting from the hyperaemia associated with the trauma of operation on the greater trochanter, must also be considered.

shaft of the seven-weeks-old goats averaged slightly more than two centimeters. This represents an actual loss of the total trochanteric-condylar length growth of 22 per cent.

The average shortening which resulted from fusion of the capital epiphysis, measured from the apex of this epiphysis to the knee joint, was one centimeter, or a total loss of growth of the shaft of 11 per cent.

If a comparable degree of shortening results within six years following multiple drilling of the neck of the femur of a child afflicted with Legg-Calvé-Perthes disease, the disability will not be inconsequential. The end result of such surgery must be sought ten or twelve years after infliction of the specific trauma.

DISCUSSION

The contention of Bozsan, Ferguson and Howorth, and others that drilling the neck of the femur, with extension of the drill into the femoral

head, may hasten revascularization may be substantiated by the evidence which they present. When this procedure is proposed for treatment of fractures of the neck of the femur, we are not prepared to disagree. Drilling of the neck of the femur to promote healing after slipping of the femoral epiphysis may be justified if it does promote an earlier union between the capital epiphysis and the metaphysis of the neck. The average patient suffering from epiphyseolysis is at least approaching the age of puberty and skeletal maturity. Furthermore, most of these patients do not recover completely, regardless of the type of treatment, until fusion and growth arrest take place.

The patient with Legg-Calvé-Perthes disease, however, presents a very different problem. Granted that the pathology includes aseptic necrosis of the capital femoral epiphysis and that the process of replacement by creeping substitution is exceedingly tedious, requiring two or more years, nevertheless any procedure which may produce growth disturbance in the femur of a young child should be considered radical and ill advised. The average age at onset of Legg-Calvé-Perthes disease is approximately seven years. At this age most of the length growth of the bones has not yet taken place. The risk of a deformity of the hip should be avoided by the surgeon who is charged with the care of a patient with a self-limiting disease.

CONCLUSIONS

1. Surgical trauma to the greater trochanter of the hip of a growing animal, produced by multiple drilling or curettage of the epiphyseal-cartilage plate, results in growth arrest with deformity and shortening of the greater trochanter. There is an associated coxa valga of the neck of the femur.

2. Surgical trauma to the epiphyseal-cartilage plate of the head of the femur by multiple drilling or by curettage uniformly results in growth arrest, which produces a short femoral neck, an irregular contour of the head of the femur, coxa vara, and a functional shortening of the shaft of the femur, as measured from the articular surface of the head to the articular surface of the knee.

3. The operation of drilling the necks of the femora of young children for the purpose of hastening revascularization of the head in cases of Legg-Calvé-Perthes disease is a very questionable procedure.

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TREATMENT OF OSTEOGENIC SARCOMA*

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The author's first paper on this subject[1] offered evidence that early amputation is not the best treatment of osteogenic sarcoma, and recommended delay of amputation with use of radiation, or excision, or both before amputation. The present paper gives further indications that early amputation is not the best treatment, and analyzes cases seen within two months of onset of symptoms to show that lack of haste in amputating improved results.

DEFINITIONS

Early amputation is defined as amputation before the seventh calendar month after onset of symptoms.

Survivors are defined as patients alive more than five years after the last treatment of the local lesion with no evidence of tumor at the last report.

STATISTICAL STUDY

The cases studied are the first 400 cases of undisputed osteogenic sarcoma which had the necessary data for tabulation, recorded in the Registry of Bone Sarcoma of the American College of Surgeons.

The favorable results obtained at various clinics or hospitals registering ten or more cases included in this series appeared to be proportionate to their lack of haste in amputating (Table I). The higher percentage of survivors was obtained at the clinics having the higher percentage of late amputations.

TABLE I

RESULTS OF TREATMENT OBTAINED IN 400 CASES OF BONE SARCOMA BY HOSPITALS AND CLINICS REGISTERING TEN OR MORE CASES, WITH NUMBER AND PERCENTAGE OF LATE AMPUTATIONS

Clinic	Cases	Survivors		Late Amputations	
		No.	Per Cent.	No.	Per Cent.
A	13	5	38.4	8	61.5
B	30	6	20.0	11	36.7
C	69	10	14.5	19	27.5
D	12	1	8.3	3	25.0
E	12	1	8.3	2	16.7
Other Clinics	264	40	15.2	81	30.7
Total	400	63	15.8	124	31.0

* Presented at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Boston, Massachusetts, on January 24, 1940.

TABLE II

TREATMENT AND RESULTS OF 400 CASES OF BONE SARCOMA CLASSIFIED ACCORDING TO SEX

Treatment	Male				Female			
	Cases		Survivors		Cases		Survivors	
	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.
Early amputation	94	37.3	8	8.5	40	27.0	3	7.5
No amputation	80	31.7	9	11.3	62	41.9	7	11.3
Late amputation	78	31.0	22	28.2	46	31.1	14	30.4
Total	252	100.0	39	15.5	148	100.0	24	16.2

Males and females had similar survival rates with each of the various types of treatment indicating that the disease was equally malignant in the two sexes. Females were treated without amputation more often, and by early amputation less often than the males. This did not cause the females to have the higher death rate that would be expected if early amputation were the best treatment (Table II).

Early amputation was used more frequently in cases registered in later years as compared to the earlier years. The increase in early amputations was not accompanied by an increase in survivors. The campaign for earlier amputations resulted in an increase in very early amputations

TABLE III

RESULTS OF TREATMENT OF 400 CASES CLASSIFIED ACCORDING TO PERIOD OF REGISTRATION OF CASES WITH THE REGISTRY OF BONE SARCOMA

Treatment	First 165 Cases				Next 135 Cases				Last 100 Cases			
	Cases		Survivors		Cases		Survivors		Cases		Survivors	
	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.
Amputation at 1 to 3 months	17	10.3	1	5.9	24	17.8	1	4.2	20	20.0	1	5.0
Amputation at 4 to 6 months	26	15.8	4	15.4	27	20.0	4	14.8	20	20.0	0	0.0
Total early amputations	43	26.1	5	11.6	51	37.8	5	9.8	40	40.0	1	2.5
No amputations	69	41.8	8	11.6	43	31.8	4	9.3	30	30.0	4	13.3
Late amputations	53	32.1	15	28.3	41	30.4	13	31.7	30	30.0	8	26.7
Total	165	100.0	28	17.0	135	100.0	22	16.3	100	100.0	13	13.0

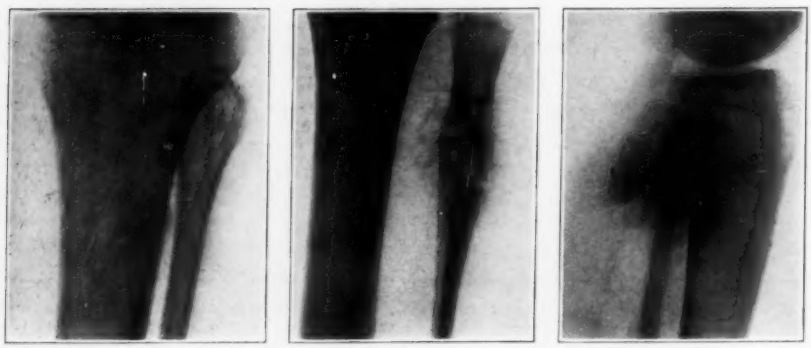

FIG. 1

Three examples of osteogenic sarcoma of the fibula treated by amputation in the second month after onset of symptoms. All patients died. Registry numbers: 707; 637; 1241.

among the early amputations in the later periods of the Registry. Early amputations increased approximately 50 per cent., very early amputations approximately 100 per cent., but survivors of early amputation decreased from 11.6 to 2.5 per cent. Is very early amputation deadly? (Table III.)

CASES SEEN WITHIN TWO MONTHS OF ONSET OF SYMPTOMS

Some cases seen within two months of onset of symptoms were becoming rapidly worse, and clinically could properly be judged wildly malignant. Such patients were not treated by early amputation; they regularly received radiation only, or no treatment at all.

The cases treated by amputation within two months of onset of symptoms included all varieties of early osteogenic sarcoma. Most of them warranted the hope that amputation was being performed early enough to save the patient if that hope ever could be warranted. The accompanying illustrations depict some of these cases; each patient had amputation within two months of onset of symptoms, and subsequently died. Only one out of thirty-eight patients so treated survived. Similar cases, seen equally early, had other treatment before amputation, and

TABLE IV

RESULTS OF AMPUTATION ON PATIENTS ELEVEN TO TWENTY YEARS OF AGE SEEN WITHIN TWO MONTHS OF ONSET OF SYMPTOMS

Treatment	Cases		Survivors	
	No.	Per Cent.	No.	Per Cent.
Amputation in 1 or 2 months	29	51.8	1	3.4
Amputation in 3 to 6 months	20	35.7	4	20.0
Amputation after 6 months	7	12.5	2	28.5
Total	56	100.0	7	12.5

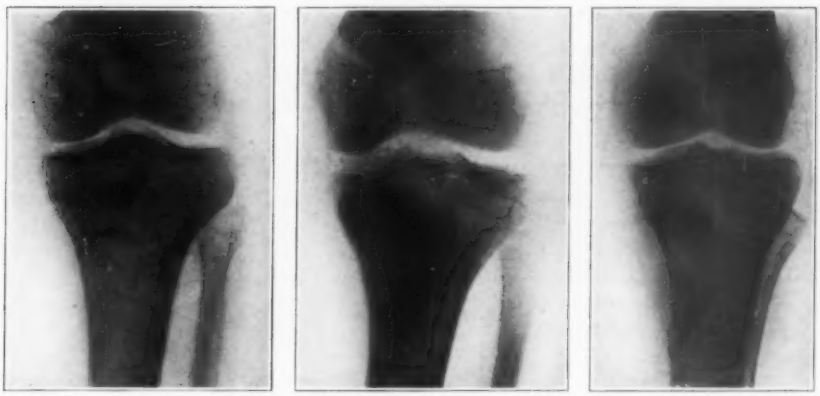

FIG. 2

Three examples of osteogenic sarcoma of the tibia treated by amputation in the first or second month after onset of symptoms. All patients died. Registry numbers: 683; 474; 1228.

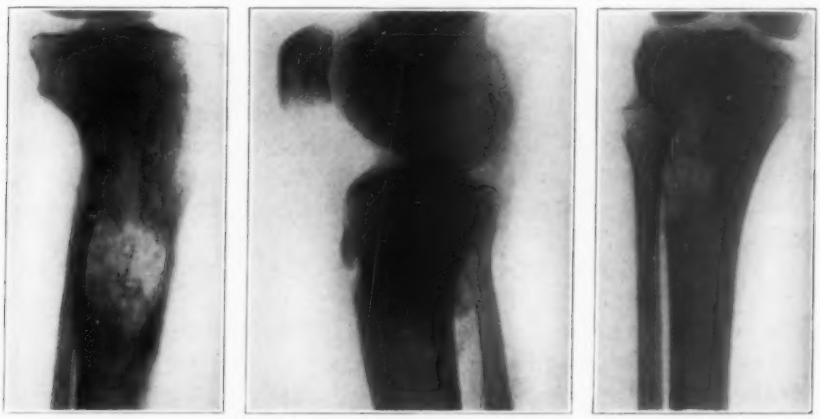

FIG. 3

Three examples of osteogenic sarcoma of the tibia treated by amputation in the first or second month after onset of symptoms. All patients died. Registry numbers: 1239; 1291; 1326.

many patients survived. Such results, presented in Tables IV, V, and VI, condemn very early amputation.

Of 107 patients seen within two months of onset of symptoms twenty had no treatment, radiation only, or excision only. Five others, of whom two survived, were treated by excision and radiation without amputation. These survivors were cases of possibly low malignancy, and are, therefore, dismissed from further consideration. It might be pointed out, however, that in four other cases of possibly low malignancy, seen early, the patients were treated by early amputation, and died.

There remain eighty-two cases seen within two months of onset of symptoms and treated by amputation (Table VI).

TABLE V

RESULTS OF AMPUTATION FOR SARCOMA OF THE DISTAL FEMUR AND PROXIMAL TIBIA IN CASES SEEN WITHIN TWO MONTHS OF ONSET OF SYMPTOMS

Treatment	Distal Femur				Proximal Tibia			
	Cases		Survivors		Cases		Survivors	
	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.
Amputation in 1 or 2 months	16	42.1	1	6.2	11	50.0	0	0.0
Amputation in 3 to 6 months	19	50.0	3	15.8	7	31.8	1	14.3
Amputation after 6 months	3	7.9	0	0.0	4	18.2	1	25.0
Total	38	100.0	4	10.5	22	100.0	2	9.1

Seventeen of the eighty-two cases seen very early were judged, histologically, to be of unusually high malignancy, but this does not explain the poor results of very early amputation, as the cases of unusually high malignancy formed only 13 per cent. of those having amputation in two months, 25 per cent. of those having amputation in three to six months, and 30 per cent. of those with late amputation. The only one of these patients who survived had radiation preceding amputation three months after onset.

The age period from eleven to twenty years produced the only survivors after early amputation, but even in this favorable age period the earlier amputations gave the poorer results (Table IV).

The distal portion of the femur and the proximal portion of the tibia were the sites which produced the only survivors after early amputation,

TABLE VI

EFFECT OF RADIATION ON RESULTS OF AMPUTATION IN EIGHTY-TWO CASES SEEN WITHIN TWO MONTHS OF ONSET OF SYMPTOMS

Time of Amputations	Total Amputations				Amputation with No Radiation				Amputation after Radiation			
	Cases		Survivors		Cases		Survivors		Cases		Survivors	
	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.
1 or 2 months	38	46.3	1	2.6	35	63.6	1	2.8	3	11.1	0	0.0
3 to 6 months	31	37.8	4	12.9	16	29.1	1	6.2	15	55.6	3	20.0
After 6 months	13	15.9	3	23.1	4	7.3	0	0.0	9	33.3	3	33.3
Total	82	100.0	8	9.8	55	100.0	2	3.6	27	100.0	6	22.2

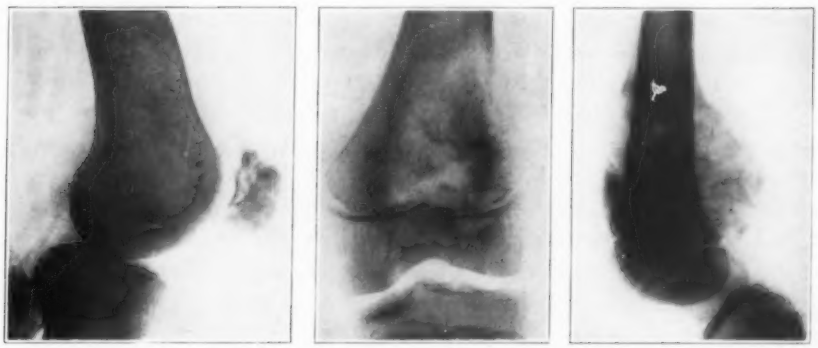

FIG. 4

Three examples of osteogenic sarcoma of the femur treated by amputation in the first month after onset of symptoms. All patients died. Registry numbers: 1329; 761; 1319.

but even at these favorable sites the earlier amputations gave the poorer results (Table V).

Amputation without previous radiation yielded poor results in the cases seen early after onset of symptoms (Table VI).

Thus, in the eighty-two cases seen within two months of onset of symptoms, and treated by amputation, neither age, site, variation in treatment, nor degree of malignancy estimated histologically explains the fact that the earlier amputations had the poorer results.

In no case did the patient survive amputation in the first month after onset of symptoms.

In no case did the patient survive early amputation if aged one to ten or over twenty.

No patient survived early amputation if the lesion was not at the distal portion of the femur or the proximal portion of the tibia.

The advocates of early amputation in osteogenic sarcoma of an extremity may persist in amputating as early as the third month after onset of symptoms, if the patient is between eleven and twenty years of age, and has a lesion at the distal portion of the femur or the proximal portion of the tibia. However, in any other instance they can offer no tangible hope of success, and should, therefore, agree to the delay of amputation which does offer hope of success.

The best treatment to be used while amputation is delayed is still undetermined, but the following are recommended, with the choice depending upon the surgical feasibility of the operative procedures:

1. Radiation.
2. Excision and radiation.
3. Excision and implantation of bone graft or chips, with or without radiation.

If excision is used, it should be repeated if recurrence becomes evident before amputation is performed. The interval between the last

excision and amputation should not be less than three weeks, and probably should not exceed two months, if benefit is to be derived from combining the two treatments.

The optimum time for amputation is a quiet period in the course of the disease,—a period when the patient is not losing weight; when the phosphatase content of the blood is not elevated; when there has been no sudden or marked increase of pain or swelling for two months; and when there has been no recent marked increase of mass or destruction demonstrable roentgenographically. Such periods occur with some frequency after the first six months of osteogenic sarcoma, and earlier in the course of the disease may be produced with the potent aid of radiation.

Whatever one may select as the treatment of choice, it can be definitely stated that very early amputation in osteogenic sarcoma of an extremity does not appear to be the best treatment.

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SURGICAL TREATMENT OF OSTEO-ARTHRITIS OF THE HIP JOINT

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This investigation was carried out in an endeavor to evaluate the merits of the more modern methods of surgical treatment of osteo-arthritis of the hip joint. Between January 1, 1926, and December 31, 1937, inclusive, seventy-seven patients suffering from osteo-arthritis of the hip joint were subjected to various surgical procedures at The Mayo Clinic, and the present paper is based on the clinical, laboratory, roentgenographic, and surgical findings in these cases.

There is no one etiological agent which is common or equally active in all cases. The pathological features are rather the result of the long-continued and united action of a multiplicity of small factors, each of which contributes its quota to the final whole.

The average age at onset among men, as evidenced by our cases, was fifty-two and seven-tenths years and that among women was forty-seven and five-tenths years. Men tended to be affected two and a half times as commonly as women. There seemed to be a definite relationship between obesity and the onset of osteo-arthritis. The presence of coxa vara, coxa valga, Perthes' disease, loose bodies, or subluxation as described by Wiberg, may predispose to the onset of osteo-arthritis among persons in the younger age groups, as demonstrated by sixteen of our cases.

TREATMENT

The case of the person suffering from severe osteo-arthritis (Fig. 1), while not so tragic as that of an individual crippled by rheumatoid arthritis, is nevertheless a serious one. Here we have a man, otherwise physically capable and in robust health, who is rendered useless and frequently becomes a hanger-on of charitable associations, on which he is dependent for his daily bread, all because of a painful hip joint. There are also the patients, who, disgruntled and disappointed in the benefits to be had at the hands of the orthodox members of the medical profession, crowd the consulting rooms of unorthodox practitioners. Although it is manifestly impossible to repair an architecturally distorted joint, surgical treatment does offer hope of alleviation. We know that fixation of the joint will give relief from pain, but, from the point of view of function, this is as radical a procedure as amputation performed for the cure of tumor.

It would be of great help in the treatment of osteo-arthritis if it were possible to identify certain stages of this disease for which one form of

FIG. 1
Osteo-arthritis of both hips.

treatment or another would prove specific. Unfortunately, we have not been able to state definitely on examination of the roentgenographic findings that one case would respond better to manipulation or that another was more suited to a bone-drilling operation. However, we have tried to divide our cases arbitrarily into three fairly well-defined groups, for which certain forms of treatment have been found to be suitable.

In Group A we include cases in the earlier stages of the disease, in which rarefaction or condensation is present in the femoral head and the superior border of the acetabulum, but in which no excessive hypertrophic changes have appeared. The use of manipulative measures alone or associated with the bone-drilling operation has resulted in an appreciable improvement in the condition of a number of these patients.

Group B consists of those cases in which hypertrophic changes are present on the acetabular margins and surrounding the head of the femur, so that motion is markedly restricted in all directions. Cheilotomy or acetabuloplasty appears to be the method indicated, although, in a few cases, reconstructive measures of the Whitman or Colonna type must be considered also.

Under Group C we place those cases in which the principal complaint is pain, for which relief has not been obtained by the usual measures of physical therapy or rest. These patients usually have considerable distortion of the normal contours of the femoral head and acetabulum, and

for them we advise arthrodesis. However, even in this group we shall have to modify our views if experience proves that the more recently devised method of Smith-Petersen [6], which entails the use of vitallium caps, is a better form of therapy.

In an effort to assess the benefits to be derived from the various methods of surgical treatment, we have divided our group of seventy-seven patients into subdivisions, depending on the methods used in their treatment.

Manipulation

Manipulative manoeuvres to the fullest extent of motion short of using extremes of force were carried out in eleven cases, with the objective of breaking down capsule and muscle adhesions. In those cases in which muscle spasm had produced adduction and flexion deformities, manipulation was supplemented by subsequent fixation in extension and abduction by plaster-of-Paris spicas, extending from the costal margin to the knee or toes on the affected side and to the lower third of the thigh on the sound side. While adduction and flexion could be corrected to a great degree by manipulation, casts, and, in some cases, by subsequent traction, external rotation usually defied all our efforts at correction. Fixation in plaster-of-Paris was continued over a period which varied from two weeks to two months, depending on the degree of deformity. During this period the patients could move around on crutches. After removal of the cast, physical therapeutic measures materially increased the rapidity of recovery of active movements.

Two patients were treated by manipulation and physical therapy. Of these, one, into whose joint thirty cubic centimeters of iodoform emulsion had been injected also, reported eight years later that his condition was unimproved, but no worse. The other died fourteen months after treatment without having reported on the condition of his hip joint in the interval. In nine cases the hip joints were manipulated under intravenous or spinal anaesthesia and fixed in casts as described.

Reports of the patients' condition were received from three months to eight years later. Of the entire group of eleven patients, four reported an improvement in their condition, but in only one case was this marked. Four patients stated that their symptoms were unrelieved, and an additional one claimed that his condition was worse than before the manipulation. One patient was found to have died in the interval, and from the remaining patient no reply was received. Of the nine patients whose condition was known, 44 per cent. reported improvement.

Bone-Drilling

The simplicity of the bone-drilling operation suggested by MacKenzie of Australia recommended it to our consideration. The procedure consists in drilling one large hole or a series of smaller holes from the lateral aspect of the greater trochanter through the neck into the head. The

operation may be done under local infiltration or spinal anaesthesia under roentgenoscopic control or by means of wire guides, the exact location of which has been checked by anteroposterior and lateral roentgenograms. The objective of the operation is the revascularization of the femoral head and neck; the operation itself is based on the relief from pain which followed the fracture of the neck of the femur of one of MacKenzie's patients, who had suffered from very severe and painful osteo-arthritis of that hip. When union occurred, relief of pain was so striking that it led MacKenzie to ponder on the cause and resulted in his suggesting the bone-drilling operation as a form of treatment in similar cases.

This operation was done in twenty-eight cases. In sixteen, a single drill opening—one-fourth, three-eighths, or one-half an inch (0.63,0.93, and 2.5 centimeters) in diameter—was made, whereas in twelve cases, multiple drillings were performed. In one case, in addition to drilling, the fascia lata was cut in a manner similar to that advised by Ober in treating sciatica; in two cases, arthrotomy and drilling were carried out; in two cases, the bone was drilled, and, in addition, the capsule was sectioned anteriorly. In the three cases in which capsulotomy or section of the fascia lata was performed, the hip was manipulated also. In only two cases were both hips operated on at the same time. So far as we could ascertain, the slight modifications had but little effect on the end results.

In the postoperative care of these patients, complete rest for from three to five days with heat and sedatives was given if necessary. During this period, further relief was afforded to two patients by the application of Buck's extension. Usually about the fourth day, gentle active movements or passive movements by means of a knee sling were begun. After the sixth day, in most cases, the patient was encouraged to sit up for a short period twice daily, after which crutches and a walker were provided, and the patient was urged to walk.

Twenty-five patients replied to our follow-up inquiry. The interval between the operation and the inquiry varied from two months to three years. Of the three patients who did not reply, one subsequently was found to have died about two years after operation, but we were unable to obtain any record of the state of her hip joint. Of the twenty-five patients who replied, nine were improved, and, of these nine, four were remarkably benefited. Eight were worse after the operation, and five claimed that their postoperative state was not different from their condition previous to surgical treatment. Three patients stated that they were relieved of pain, but that functional ability was not improved. Taken at its lowest value, nine out of twenty-five, or 36 per cent., were helped by drilling the hip, and 16 per cent. were markedly relieved.

Cheilotomy of the Femoral Head

The method used in this procedure was that described by Sir Robert Jones, the heads being reduced in size by from two-thirds to four-fifths. This operation was done in four cases, in each of which the acetabular

marginal excrescences were left undisturbed. Extension caliper splints were applied for from ten to fourteen days, and prolonged physical therapy was recommended following operation.

Were it possible to follow these cases for several years, one feels that the late reports would be, to say the least, disappointing. Probably it is best to consider this a more or less useless operation.

Cheilotomy of the Femoral Head and Acetabulum

This operation was carried out in six cases. The Smith-Petersen approach[5] was used in four cases, while a lateral incision was used in two. Osteophytes were removed from the head and from the acetabular margins. In five cases the hip joint was subsequently fixed in a double hip spica for from eleven to forty-two days; in one of the cases the position of the joint was maintained by Buck's extension without plaster fixation. Following removal of the cast, movements were instituted by means of the arthroplasty splint and later carried out voluntarily. The use of crutches and the walker followed. Physical therapy was employed throughout.

Three patients, at two, three, and three and a half years, reported very good results with increased range of movement, freedom from pain, and sufficient stability to allow them to discard all support. The fourth patient wrote that his condition was only fair, but was improving at the end of six months. The fifth stated that he had spells of severe pain at the end of one year. This statement conveyed the impression that he had gotten along moderately well in the interval. The sixth patient, four years after operation, reported that he was only working for his keep in a lodging house. From this survey, we concluded that 50 per cent. were very definitely benefited, and that the condition of the remaining 50 per cent. was probably fair to poor.

Cheilotomy and Bone-Drilling

In three cases, in addition to the removal of the osteophytes of the femoral head and acetabular margins, the ilium was drilled in the region just superior to the acetabular roof. The osteophytes on the inferior acetabular rim were not disturbed. In two cases, these hypertrophic growths were one inch (2.5 centimeters) thick at their bases and overhung the head like a canopy. These patients were urged to use a knee sling after four days' rest and to move the hip by the end of the second week.

One patient did not reply to our inquiry. The second, two years after operation, said that he was unable to walk on account of pain. The third, however, two years and three months after operation, reported that the pain had gone and that improvement had been steady. The other hip, however, was showing signs of similar but progressive disability. Thus, there was improvement in the condition of the two patients who were traced.

FIG. 2

Fifteen months after Whitman reconstruction operation.

Subtrochanteric Osteotomy

Only one patient was treated by this method, and he stated that four months after operation he was unable to work and could not walk without crutches.

Acetabuloplasty

This was performed in five cases after the method described by Smith-Petersen [5] in 1936. The anterior lip was removed, but care was taken to preserve the superior border in order to maintain joint stability. The hypertrophic excrescences of the acetabular margins were also removed. Passive movement was begun within a few days, and the patients were allowed to sit up by the tenth day. By the twelfth to the twenty-first day after operation, they were encouraged to attempt walking with the aid of crutches or a walker. Heat, massage, and diathermy were used as adjuvant measures in all the cases.

Of the five patients treated, one reported at the end of eight months that his condition was very much worse. The report submitted by a second patient, nine months after operation, was most encouraging. He claimed a "wonderful improvement", but he still used a cane. Two months after operation, the third patient reported that he was feeling much improved, and that the range of movement of his hip was increased.

A fourth patient admitted some slight improvement after fourteen months, but he stated that he continued to experience some pain and found it impossible to tie his shoe laces or to work. The last patient, seventeen months after operation, was able to tie his shoe laces and was conscious of a distinct improvement in the mobility of his hip.

Thus, we found that of five patients who were subjected to acetabuloplasty, the condition of four, or 80 per cent., was improved.

Reconstruction Operations

Of the thirteen patients treated in this manner, twelve were subjected to the reconstruction operation popularized by Whitman (Fig. 2), and one had the Colonna type of reconstruction. From these patients, reports were received at intervals subsequent to the operative procedure and six, on their own showing, were found to have been benefited, although one of these had a relapse after three and a half years. Five were not improved (Whitman operation in four cases, Colonna operation in one), while two were definitely worse. These reconstruction operations have a definite place in the repertoire of the orthopaedic surgeon, but success depends, as it does in so many orthopaedic conditions, on the careful selection by the surgeon of the right type of operation and case.

Arthrodesis

The intra-articular method was employed in two cases, while in four an extra-articular arthrodesis, using an iliac graft, was performed. Spinal anaesthesia was employed routinely. Postoperative fixation in a double hip spica has, in our experience, proved itself to be the best method of immobilization and was used in all cases. The patient can be turned painlessly with the minimum of trouble, and nursing measures are more easily carried out. While the possibility of bed sores is greatly reduced, if they should occur, lights and medicaments can be applied with ease. If necessary, the patient even can be slung up by one leg to an overhead bar in such a manner that all pressure can be removed from the sore and yet the security of the immobilization is not impaired. The cast is changed at the end of from one to two months; the stitches are removed and a lighter, and occasionally a single, hip spica is applied. This is left on until ankylosis occurs. If economic necessity demands it, the patient can be sent home in a cast with safety. One of our patients went home thus at the end of six weeks. As a rule, under normal conditions, bony union has occurred by the end of from six to nine months, but in osteo-arthritis it must be acknowledged that bony union does not occur readily and in some cases may never take place. When this is the case, union by fibrous tissue is the rule, and, where this is firm, a very satisfactory union may result.

In the first case, follow-up revealed that the pain had disappeared. In the second, a postencephalitic Parkinson's syndrome had developed, and, as a result, we were unable to assess accurately, two and a half years

later, the peculiar ever-changing symptoms of which the patient complained. The third, fourth, and fifth patients—one and one-half, four and one-half, and six and one-half years after operation, respectively—were free from pain, well, and, in two cases, at work. The patient in the third case was unemployed, but had had a good result. In the sixth case, the patient reported three years and nine months later that he had no pain and was able to walk five or six miles daily. This is one of those anomalous cases of arthrodesis in which, instead of ankylosis, motion results. The patient could flex his hip to 40 degrees. Function was excellent, and he was very well pleased with the end result. Roentgenographic examination demonstrated that the bone graft had formed a shelf against which the greater trochanter rested. We believe that it is quite in order to exclude the second patient from our assessment of results, because of the nature of his subsequent malady, which made his subjective symptoms of doubtful value. Thus, out of five cases, we had five good results. Even if from the technical viewpoint arthrodesis failed in one case, the ultimate end result was even better. The percentage of good results was 100, or at its lowest estimation, 80.*

RÉSUMÉ

In the seventy-seven cases of osteo-arthritis of the hip joint which have been reviewed, men predominated over the opposite sex in the proportion of fifty-five to twenty-two. The influence of severe trauma was not an outstanding feature. Forty-nine patients had suffered no initial injury, and from only twenty-eight was a definite history of trauma elicited.

From the point of view of therapy, undoubtedly, arthrodesis as performed by us has given the best results, but, while this is a procedure which is readily accepted in Europe, in America we have difficulty in convincing our patients of the benefits to be derived from a stiff hip. The average patient has a horror of an immobile joint and will refuse to consider an operation devised to produce this end, even when the diseased articulation is to all intents and purposes already stiff.

Of the other procedures, each has its place in well-selected cases. Drilling, combined with manipulative measures and followed by active movements, aided by physical therapeutic agents, has given good results in many cases. The more recent work of Smith-Petersen [6] with vitallium caps in arthroplasty of the hip joint bids fair to change our views on this operation, but, until further experience has been gained, the procedure is still *sub judice*.

Acetabuloplasty and extensive cheilotomy do give excellent results in some cases.

* It is difficult to be dogmatic in our opinions regarding this group, since we are not certain that ankylosis was obtained in all cases. The replies to our follow-up letters indicated that the patients had obtained marked clinical benefit, but, as we were not able to obtain roentgenograms demonstrating the late end results, our opinions are deductive, not factual.

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ANTERIOR TIBIAL TENDON TRANSPOSITION IN RECURRENT CONGENITAL CLUB-FOOT

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Conservatism in the treatment of congenital club-foot is well recognized. Brockman, in his monograph on the condition, states that only 50.6 per cent. required no further treatment after adequate conservative care. Kite has practically standardized the conservative treatment. He states that 90 per cent. of all club feet can be corrected by the wedge-cast method. In some cases, however, the deformity does recur or resist conservative methods of correction. The following is an end-result study of the transposition of the anterior tibial muscle tendon insertion in recurrent club-foot.

Of the three components in congenital club-foot,—adduction of the forefoot at the talonavicular joint, inversion, and the equinus of the forefoot as well as of the os calcis—inversion of the whole foot, but especially of the calcaneum, is the most important. Without complete correction of the inversion, correction of the deformity as a whole cannot be maintained. Residual metatarsus adductus is frequent after correction by any method. If the forefoot adduction is completely corrected, the inversion of the os calcis will be corrected in most instances.

In the cases here reported, recurrence of deformity occurred in spite of vigorous conservative treatment by manipulation, casts, club-foot braces, and thirty-six operations including: arthrodesis (4), decancellation of calcaneum (3), Hoke's (1), Ober's (2), Brockman's (3), osteotomy of talus (1), Achilles tenotomy (16), fasciotomy (4), and capsulotomy (2). Forceful wrenchings, resulting in stiffening of the tarsal joints, had previously been done on at least half.

On examination it was found that when active dorsiflexion of the foot was attempted the foot was supinated. The anterior tibial tendon, inserted at the first cuneiform bone and base of first metatarsal, pulled the whole foot into inversion, and exaggerated the inversion of the os calcis. This occurred with each step.

In every instance the strength of the peroneal muscles was not sufficient to evert or pronate the foot actively. In no patient had the inversion of the os calcis been completely corrected, and some degree of deformity in each component had recurred.

The average age of the patients was six and one-half years. Three were in their third year, and two in their sixteenth.

This operation consists of transferring the anterior tibial tendon insertion to the proximal end of the fifth metatarsal. An incision about

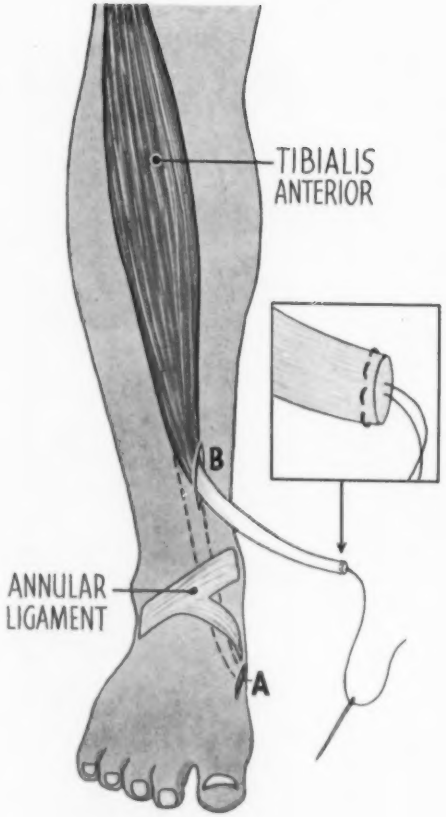

FIG. 1-A

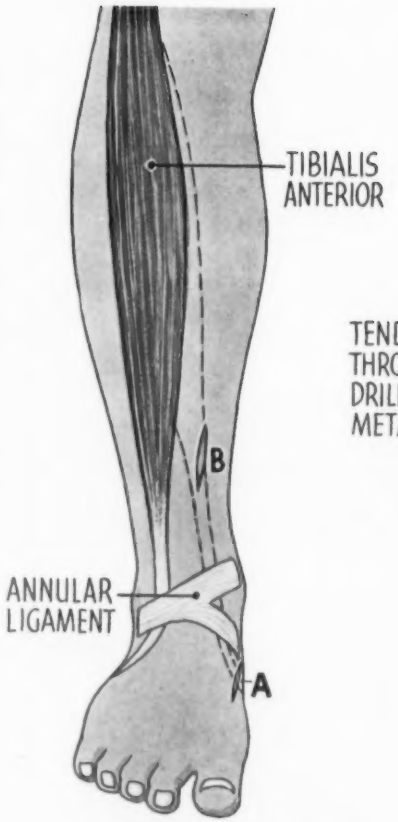

FIG. 1-B

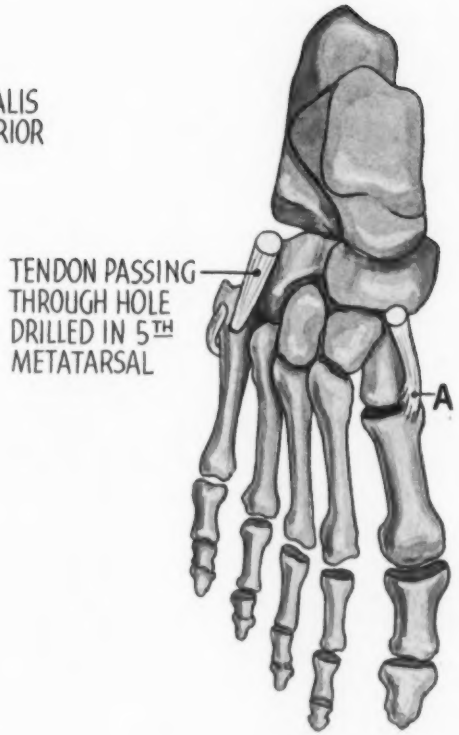

FIG. 1-C

Illustration of method of anchoring the tendon of the anterior tibial muscle through the fifth metatarsal.

Figs. 1-A and 1-B: *A*, Insertion of anterior tibial tendon in first cuneiform and first metatarsal; *B*, Incision through which tendon is pulled.

Fig. 1-C: Insertion of tendon through the proximal end of the fifth metatarsal.

FIG. 2-A FIG. 2-B FIG. 2-C

Fig. 2-A: Child seven years old with recurrence in all components of deformity.
Figs. 2-B and 2-C: Three years after anterior tibial transplantation, showing satisfactory correction of the deformity.

one inch in length is made over the anterior tibial tendon just above the ankle joint. A similar incision is made over the insertion of the anterior tibial tendon and the tendon detached. (In several instances there was found an abnormal insertion of the tendon, such as a thin, wide attachment under the first metatarsal, or a divided tendon.) The tendon is then pulled out through the upper incision. A silk suture, the ends of which should be long, is passed through the end of the tendon. A curved hemostat is passed through the upper incision and distally under the annular ligament toward the proximal end of the fifth metatarsal. A short incision over the fifth metatarsal is made and a hole drilled through the bone. The tendon is passed through the newly made channel and through the drilled hole in the metatarsal. When the tendon is too short, it is transferred to the cuboid. The tendon, secured with silk suture and chromic catgut, is threaded carefully through the hole in the bone, and the loose silk suture ends are used to anchor it laterally to the periosteum, or to the soft tissues of the sole. The subcutaneous tissues and skin are closed in layers. A circular plaster cast is applied, maintaining as much correction of the deformity as possible. Every two weeks the cast is removed and a fresh wedge cast is applied. Patients in this series wore postoperative casts for an average of eight weeks.

FIG. 3-A FIG. 3-B FIG. 3-C

A four-year end result. The operation was performed when the child was seven years old, with excellent result.

FIG. 4-A FIG. 4-B FIG. 4-C

A bilateral three-year end result. Fig. 4-A: Shows metatarsus adductus present.
Fig. 4-B: Shows the correction of the heel inversion.
Fig. 4-C: Shows the action of the anterior tibial tendon in everting the feet.

In evaluating the following figures, it must be understood that the deformity had resisted long-continued and vigorous treatment.

FIG. 5-A FIG. 5-B

A bilateral three-year end result. The operation was performed when the child was six years old, with excellent result.

Transplantation of the anterior tibial tendon was performed on fifty-six feet in forty-four patients. The influence of the operation on the adduction of the forefoot was graded excellent in nineteen feet, or 34 per cent.; good in twenty-four, or 43 per cent.; and not satisfactory in three, or 5 per cent. The effect on the adduction was not noted in ten feet, or 18 per cent.

The effect on the inversion was excellent in thirty feet, or 54 per cent.; good in twenty-two, or 39 per cent.; and had no apparent effect in four, or 7 per cent.

The effect of the operation alone on the equinus was difficult to evaluate, because wedge casts were applied for an average of eight weeks after surgery. The final end result is influenced remarkably by the degree of equinus present before the operation. Correction of the equinus is essential. In three instances, a tibial-turn operation was subsequently performed to correct the torsion of the tibia, with excellent results.

The indications for this operation are simple. If deformity recurs after vigorous conservative treatment, the mechanism of the anterior tibial tendon should be determined. If, on active dorsiflexion, the foot is inverted and the forefoot is adducted, this operation should be contemplated. If the peroneal muscles cannot evert the foot, the operation is indicated.

In no case has it been necessary to reanchor the tendon into its original insertion. All patients have been followed from one to five years.

The tendency to continued improvement is considerable, due to the mechanism of the transferred anterior tibial tendon, as well as the removal of the deformity-causing anterior tibial pull. The late end-result studies of the fifty-six feet so treated indicated excellent results in thirty-four feet, or 61 per cent.; and good results in eighteen, or 32 per cent. Satisfactory results were obtained in fifty-two, or 93 per cent., of the fifty-six feet subjected to transposition of the anterior tibial tendon. There were no poor results from the sacrifice of the anterior tibial tendon although in four feet, or 7 per cent., no beneficial effects were noted.

CONCLUSIONS

1. The deformity in club-foot does sometimes recur after apparently adequate conservative treatment.

2. The faulty mechanism of the anterior tibial muscle is a mechanical factor in this recurrence.

3. Correction of the equinus is necessary to obtain the best mechanical advantage of the transferred force.

4. End-result studies of fifty-six feet indicate that the continuous influence of the transferred force is an important factor in the correction of resistant cases.

5. No bad effects were noted from the sacrifice of the anterior tibial tendon.

6. Satisfactory end results were obtained in 93 per cent. of the feet so treated.

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LAMBRINUDI OPERATION FOR DROP-FOOT*

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In 1927 and again in 1933 Mr. C. Lambrinudi of Guy's Hospital, London, proposed a "new operation on drop-foot". The operation has been successfully performed and accepted by many orthopaedic surgeons. The object of this paper is to present the indications, the contra-indications, and the technique of the operation and to emphasize the surgical principle on which it is based.

The principle as expressed by Lambrinudi is that "The best method to stabilize a joint without ankylosing it is to allow it to lock in a normal manner". The principle then is a physiological or natural bone check. When in complete equinus, the foot cannot drop any further because the posterior portion of the astragalus abuts against the tibia. The anterior capsule of the ankle joint is taut in plantar flexion and may be an important factor, as well as the natural bony obstruction, in the locking mechanism. The Lambrinudi operation controls drop-foot by correcting the equinus deformity at the subastragalar joint and arthrodesing the tarsus in a functional position to the astragalus, which is locked in complete equinus within the mortise of the ankle joint.

INDICATIONS AND CONTRA-INDICATIONS FOR THE OPERATION

Lambrinudi devised this operation for the correction of drop-foot or equinus deformity in a foot with an active gastrocnemius soleus muscle and inactive or paralyzed dorsiflexor and peroneal muscles. If the peroneal muscles are active and strong, then this operation is not indicated because a more constructive and logical procedure is triple arthrodesis combined with anterior transposition of the peronei with implantation of their tendons to the dorsum of the tarsus. The Lambrinudi operation would definitely improve a flail or dangle foot but the writer believes that a dangle foot is best treated by a panastragalar and calcaneocuboid arthrodesis with the foot in slight equinus. The operation is not indicated if the patient has an unstable knee joint which requires the support of a brace. If there is considerable shortening of the extremity, the operation may not be indicated if the equinus deformity serves to compensate for the shortening, with an addition to the height of the heel of the shoe.

A mild equinus position of the foot due to contracture of the Achilles tendon provides stability to the knee when the quadriceps femoris is paralyzed. If this situation is present, the equinus deformity should never be completely eliminated by any surgical procedure. The foot

* Presented at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Boston, Massachusetts, on January 24, 1940.

FIG. 1

Lateral roentgenogram taken with the foot in complete equinus. A wedge of bone is removed from the head, neck, and body of the astragalus so that the inferior surface of the astragalus forms a plane at an angle of about 95 or 100 degrees with the vertical axis of the leg. The tarsus is then arthrodesed to the remaining portion of the astragalus.

which Lambrinudi selected for this operation may present a varus deformity due to an active and unopposed tibialis posterior muscle. The overaction of this muscle would be a deforming factor and therefore it should be eliminated by exposure and excision of a small segment of the tendon through a one-inch incision preliminary to the main dissection. Lateral instability of the astragalus within the mortise of the ankle joint is not infrequently the reason for the failure of stabilizing operations at the subastragalar joint, and the Lambrinudi operation would be no exception. If this undesirable factor is present, a better functioning foot can be secured by a panastragalar arthrodesis which stabilizes the ankle joint as well as the subastragalar articulation. The age of the patient is an important consideration; the operation, like other arthrodesing methods, should not be performed before the age of about eight years. An extreme forefoot equinus should not be confused with an equinus deformity of the entire foot, since it will demand a different surgical technique for correction.

As suggested by Fitzgerald and Seddon, the operation is of special value in deformities of the foot due to paralysis of origin other than the residual paralyses of anterior poliomyelitis. The drop foot of hemiplegia, permanent common peroneal nerve injury, congenital equinovarus deformity which has resisted manipulative corrections, and equinus de-

formities with loss of dorsiflexor and peroneal muscles, due to trauma and burns, may find solution by the Lambrinudi operation.

TECHNIQUE

A lateral roentgenogram of the affected foot and ankle in complete equinus is essential for study in planning the planes of bone section before the actual surgical operation. The roentgenogram (Fig. 1) shows the astragalus locked in the extreme of plantar flexion and one can determine with accuracy the degree of the angle and the size of the wedge of bone which is to be removed from the head, neck, and body of the astragalus, so that the inferior surface of the astragalus will form a plane of about 95 degrees in relation to the vertical axis of the leg (Fig. 2). The foot should be placed at an angle of 95 degrees to the leg if there is complete paralysis of

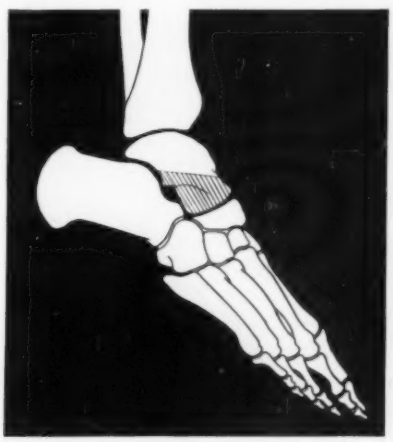

FIG. 2

Fig. 2: The shading indicates the portion of the head, neck, and body of the astragalus removed to correct the equinus deformity at the subastragalar joint. The inferior surface of the remaining portion of the astragalus forms a plane of about 100 degrees in relation to the vertical axis of the leg. The equinus deformity is corrected when the tarsus is arthrodesed to the astragalus, which is locked within the ankle joint mortise.

FIG. 3

Fig. 3: After the wedge of bone is removed from the astragalus, the superior surface of the os calcis is denuded of cartilage and bone to form a plane parallel with the horizontal axis of the foot. Cartilage is removed from the calcaneocuboid joint. Finally a notch is made horizontally from side to side in the posterior and inferior portion of the scaphoid bone. This notch will receive the sharp anterior border of the astragalus.

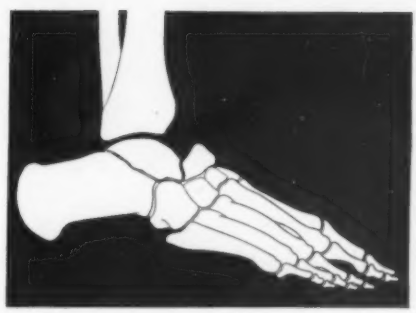

FIG. 4

The Lambrinudi operation controls drop-foot by correcting the equinus deformity at the subastragalar joint and arthrodesing the tarsus in functional position to the astragalus, which is locked in complete equinus within the mortise of the ankle joint.

FIG. 5

Roentgenographic evidence of bony union between the astragalus and the tarsus with correction of the drop-foot deformity at the subastragalar joint.

the dorsiflexor and peroneal muscles; however, an angle of 100 degrees should be planned if there is some available power in the dorsiflexor muscles or the peronei which may be transplanted to the dorsum of the tarsus. The foot should never be placed at a right angle to the leg because such a position does not permit the wearing of an ordinary heel and also because it prevents the active gastrocnemius from coming into action as a "push off" mechanism when walking.

The subastragalar joint is exposed in the usual manner through a long lateral curved Kocher incision. Complete medial dislocation of the tarsus at the subastragalar joint is essential after sectioning the peroneal tendons, opening the astragaloscaphoid and calcaneocuboid joints and dividing the interosseous and external lateral ligaments of the ankle. The wedge of bone, which was determined when the lateral roentgenogram was studied, is removed from the head, neck, and body of the astragalus after the inferior surface of the astragalus is completely denuded of cartilage (Fig. 2). Cartilage and bone are then removed from the superior surface of the os calcis to form a plane which is parallel with the horizontal axis of the foot. The cartilage is removed from the calcaneocuboid joint, and, finally, a notch is made horizontally from side to side in the posterior and inferior portion of the scaphoid (Fig. 3). The sharp anterior margin of the remaining portion of the astragalus is then firmly wedged into the prepared notch of the scaphoid while the superior bleeding

surface of the os calcis is approximated to the inferior bleeding surface of the astragalus (Fig. 4). The foot is now at the desired angle of 95 or 100 degrees to the axis of the leg and cannot be plantar-flexed further, since the astragalus is locked at the ankle joint in complete equinus. The incision is closed and a long plaster-of-Paris leg cast is applied to maintain the position of the foot and permit postoperative elevation of the extremity. About the beginning of the third week, a short walking cast is applied with a rubber or felt heel incorporated within the plaster. Periods of elevation are gradually decreased while periods of walking with weight-bearing on the cast are gradually increased. Plaster fixation is continued until there is roentgenographic evidence of bony union (Fig. 5) at the subastragalar and calcaneocuboid joints, which requires between three and five months.

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A CLINICAL STUDY OF ONE HUNDRED PATIENTS SUBJECTED TO SIMPLE EXOSTOSECTOMY FOR THE RELIEF OF BUNION PAIN

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The following study was undertaken in an attempt to evaluate the operation of simple exostosectomy. This procedure attempts to relieve the bunion pain by removing the projecting medial portion of the first metatarsal head. It does not correct the hallux valgus.

Before starting the study of the operated group, many roentgenograms of feet exhibiting hallux valgus were reviewed. Some of the patients showed hallux valgus on one foot and not on the other. From these preoperative roentgenograms, the following conclusions are drawn:

1. The size of the exposed portion of the metatarsal head is approximately in direct proportion to the degree of great-toe valgus.

2. In the majority of feet with hallux valgus, the first metatarsal heads show straightening of the medial border, and, in addition, many of the heads appear almost square (Fig. 1). The amount of new bone present, which changes the shape of the head or causes enlargement of it, rarely exceeds one-sixteenth of an inch in thickness. The changes that are seen in the shape of the first metatarsal head represent areas of pressure atrophy and absorption of the cortex with bone repair. The projecting medial portion of the metatarsal head, therefore, is not an exostosis in the true sense of the word.

FIG. 1

Illustrates square appearance of metatarsal head. This foot is an ideal example of the type suitable for simple exostosectomy.

3. Many of these first metatarsal heads show circular punched-out areas just under the medial cortex. These areas represent subcortical fibrocystic degeneration of bone (Fig. 4-A).

4. If the proximal phalanx maintained its normal articulation with the first metatarsal head, and did not subluxate laterally, there would be no medial prominence of the metatarsal head, and no bunion would develop.

FIG. 2-A

FIG. 2-B

Calcification in bursae overlying first metatarsal heads.

5. The size of the bunion, as reflected in the soft-tissue outline in the roentgenogram, may be large or small, depending upon the degree of inflammatory reaction in the soft tissue. The bursa overlying the prominent portion of the metatarsal head occasionally calcifies (Figs. 2-A and 2-B).

The 100 patients in the group operated upon were examined by the authors from nine months to six years after operation. The average post-operative period for the whole group was thirty months. The series comprised ninety-two women and eight men. At time of operation the youngest patient was fourteen years of age, and the oldest was sixty-nine. No wound infection occurred in the 199 feet operated upon. These patients were not consecutive cases, because not all the patients who were asked to return did so.

The operative technique used in these 100 cases may be described in general as follows:

Under local or general anaesthesia, a two-inch dorsomedial incision is started one-half inch distal to the first metatarsophalangeal joint. This incision is carried proximally in a gentle curve to pass above the dorsal outline of the bursal sac and thence straight up the metatarsal shaft (Fig. 3, *A*).

The dorsal vein is preserved and, in most instances, is retracted laterally. The bursal sac is excised if it contains calcareous material, is nodular, or is greatly thickened, but otherwise it is left intact.

The capsule is incised in line with the skin incision. The joint space

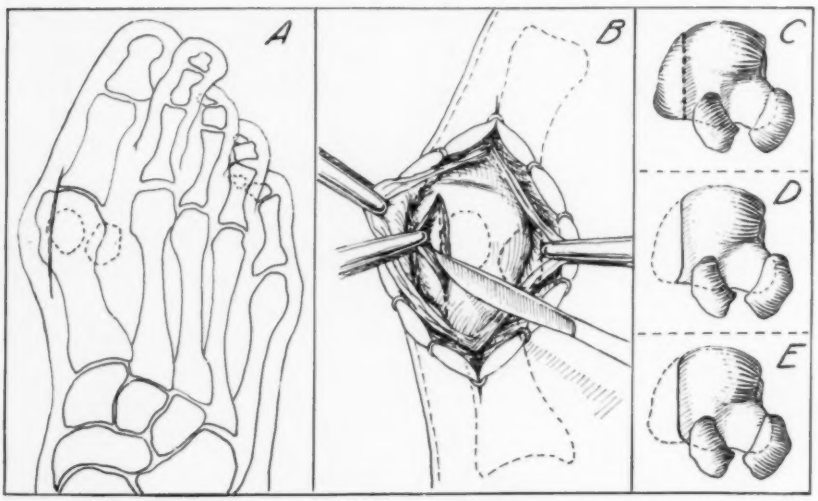

FIG. 3

Diagram illustrating operative procedure.

is located, and the knife is carefully inserted between the medial side of the capsule and the joint space. The knife is kept close to the metatarsal head, while it separates the capsule from the bone for a sufficient length to expose the entire medial side of the metatarsal head and a small portion of the adjacent shaft (Fig. 3, *B*).

The amount of bone to be removed is determined from the gross appearance of the metatarsal head. The cartilage of the metatarsal head articulating with the phalanx is white, glistening, and smooth. The cartilage not functioning as articular surface is of darker color, dull in appearance, rough and spotty in distribution. A small vertical groove often accentuates the demarcation between these two areas.

The osteotome is placed on the metatarsal head in such a manner that it is parallel to the vertical axis of the metatarsal shaft and is pointing slightly medially. It is then driven through the bone, removing the whole medial portion of the metatarsal head not functioning as articular surface (Figs. 3, *C* and 5).

In older patients, especially, splitting of the metatarsal shaft is guarded against by notching the cortex of the shaft where the osteotome will eventually come out, and by not using the osteotome as a lever.

The bone is inspected. Any sharp edges are rounded off. All loose pieces of bone are removed.

The wound is closed in layers. Fine chromic gut suture is used for the capsule, fine plain gut suture for the superficial layers, and silk for the skin.

The toe is bandaged with the purpose of holding it toward a varus position and in slight plantar flexion. The wound is dressed the following day. Active toe motion is encouraged.

The sutures are removed on the tenth day, and the patient is allowed up in comfortable shoes. Physiotherapy is given, which consists of foot and toe exercises, massage of the feet, and contrasting foot baths.

THE RESULTS

A. Satisfactory

In this series of 100 patients, seventy-seven were entirely relieved of all bunion pain and discomfort. Eleven patients had vague aches and pains about the first metatarsophalangeal joints which suggested arthritis. The ages of these latter patients varied widely, and no absolute cause for their mild discomfort could be determined. All eleven of these patients were pleased with the operation, and considered the results excellent. We consider that these eighty-eight patients had satisfactory results because they were contented with the operation and would recommend it to others.

Course After Operation

1. *Length of Disability:* The average time before close-fitting shoes were worn was six weeks. The majority of patients did not return to work until seven weeks after operation. Many stated they were more

FIG. 4-A

Illustrates marked degree of hallux valgus with dislocation of second toe on left. Arrow points to area of subcortical fibrocystic degeneration. Note marked rotation and marked subluxation of great toes with displacement of sesamoid bones.

comfortable three weeks after operation than they had been before operation. Many others contended that they could have gone to work earlier if necessary. Eight to ten weeks after operation all evidence of callosity and bursa had disappeared from the exostosectomy site.

2. *Great-Toe Motion:* Before operation many patients, particularly in the older group, showed osteo-arthritic changes such as slight lipping of the joint margins. The motion existing before operation, which in every case was ample, was not diminished by surgery more than 10 degrees in any case. This loss of motion was clinically insignificant.

3. *Metatarsalgia:* Many feet with hallux valgus show pronated rearfeet, splayed and supinated forefeet, and hypermobile first metatarsal bones. When these people stand, an undue portion of the body weight is borne on the second and third metatarsal heads. This leads to varying degrees of metatarsalgia. Some patients complained of this condition before operation, but apparently, in most of the patients, it was absent or overshadowed by the bunion pain. Following recumbency in bed and relief from bunion pain, metatarsalgia for a few weeks became, with a number of patients, a predominant complaint. Physiotherapy and correctly fitted metatarsal pads aided these patients.

FIG. 4-B

Same case as shown in Fig. 4-A, two months after simple bilateral exostosectomy of first metatarsal head and amputation of second left toe.

4. *Roentgenographic Findings After Operation:* By comparing the preoperative x-rays with those of the same feet taken one to six years after operation, it was found that the configuration at the exostosectomy site remained about the same. A thin layer of surface condensation at the exostosectomy site marked the area of bone repair. This layer never exceeded one-thirty-second of an inch in thickness. There were no changes suggesting sclerosis of bone or osteo-arthritis as are so frequently seen following partial transverse resection of the metatarsal head.

In many instances, the degree of hallux valgus was measured from comparable roentgenograms taken before operation and at the time of the last examination. The degree of hallux valgus was found to be practically the same as before operation.

Splaying of the forefoot, as measured from these roentgenograms, was found to be mild, and in none of these eighty-eight cases an important factor.

B. Unsatisfactory

The remaining twelve patients presented disappointing results. Eleven of these patients had both feet operated upon. Of the twenty-

FIG. 4-C

Same case as shown in Figs. 4-A and 4-B, four months after simple exostosectomy and amputation of second left toe. Both feet were painful, with dislocation of left great toe. Note how the sesamoid bones have shifted in position.

FIG. 5

Roentgenogram taken one year after exostosectomy. Arrow points towards loose piece of bone not removed at time of operation. Note extent of exostosectomy, and that the exostosectomy site blends with the metatarsal shaft.

FIG. 6

Illustrates inadequate removal of medial side of first metatarsal head. This prominence was later removed with complete relief of symptoms. Note also exostosectomy of fifth metatarsal head.

three feet operated upon, nineteen were painful. The cause of the pain and disability following operation was due either to a faulty selection of the patient for this operation (three cases), or to some fault in operative technique.

1. *Selection of the Patient:* From the study, we conclude that patients subjected to simple exostosectomy should fulfill the following requirements:

a. The patient should be interested primarily in the relief of bunion pain, not in the correction of the deformity.

b. Circulation in the feet must be adequate.

c. Sesamoiditis should not be present. Failure to observe this condition previous to operation may at times influence one to regard this operation as the cause of the sesamoid pain. Usually this is not the case. Careful examination and special roentgenographic views for the study of the sesamoid bones before operation will help one to rule out this condition (Fig. 8).

d. The great-toe motion at the first metatarsophalangeal joint

FIG. 7-A

Illustrates too generous removal of medial side of first metatarsal head without trimming of adjacent phalangeal base. The prominent phalangeal base was responsible for the persistence of symptoms.

FIG. 7-B

Same foot as in Fig. 7-A, one year after trimming of prominent phalangeal base. Excellent great-toe motion. Patient completely relieved of pain and discomfort.

should be free and painless. Great-toe motion should be considered definitely limited when the great toe will not dorsiflex passively through an arc of at least 50 degrees on the metatarsal shaft. Passive enforcement of this motion should not cause pain. In estimating the dorsal range of great-toe motion, the first metatarsal bone must not be supported or elevated. Roentgenograms of feet with limited great-toe motion frequently show osteo-arthritic changes or osteophyte production, contributing to the limitation of great-toe motion. These feet should not be chosen for simple exostosectomy.

e. The hallux valgus should be under 50 degrees when estimated by the angle which the great toe makes with the metatarsal shaft. Further, the anatomical relationship between the great toe and the second toe must be normal. If the great toe overlies or underlies the second toe, or if the second toe is cocked up, is absent, or needs to be amputated, a simple exostosectomy is not indicated. If this operation is done, marked increase in the hallux valgus may occur. This increase in valgus may become so pronounced as to cause lateral dislocation of the great toe on the metatarsal head (Figs. 4-A, 4-B, and 4-C).

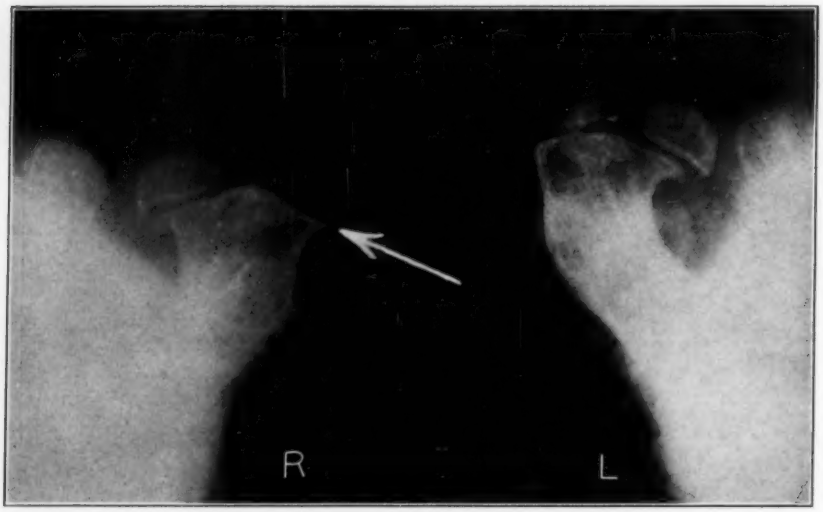

FIG. 8

Special sesamoid view, taken to show prominent medioplantar border on right first metatarsal bone. Note how site of exostosectomy has been gouged out, leaving a prominent ridge on the medioplantar border. The left first metatarsal shows a satisfactory exostosectomy. Note the smooth flat surface with well-rounded medioplantar border. (Compare with Figures 3, *D* and 3, *E*.)

f. If the above are considered, advanced age in itself does not contra-indicate the procedure.

2. *Operative Faults:*

a. The failure to remove a loose bone spicule at time of operation may lead to a painful bony nodule (Fig. 5).

b. Inadequate removal of the medial side of the metatarsal head may result in the bunion persisting. The most common place where insufficient removal occurs is the dorsomedial portion of the metatarsal head. This bony prominence may be unduly pressed by the shoe, and a small painful bunion may result (Fig. 6).

c. Too generous removal of the medial side of the metatarsal head may cause the medial side of the base of the first phalanx of the great toe to be prominent, and cause pain from shoe pressure (Fig. 7-A). This can be avoided if careful palpation of the phalanx and the cut surface of the head is done at operation, and the two surfaces made flush with each other (Fig. 7-B). With hallux valgus, the sesamoids are displaced laterally to a greater or lesser extent. If the exostosectomy is correctly done and not too much of the head is removed, no fear of removing the articulating surface for the medial sesamoid need be entertained (Fig. 8).

d. The most frequent cause of persisting pain due to operation, and the mistake that is most easily made, is leaving a sharp medioplantar border on the first metatarsal head. This is caused by an inadequate chisel cut that fails to take off the complete side of the metatarsal head. The result is that a cortical ridge is left on the medioplantar border of the

metatarsal head (Fig. 8). That the pain is caused by shoe pressure against this ridge is demonstrated by the fact that these people can walk bare-footed without pain. The point of tenderness occurs most frequently where one expects the medial sesamoid to be, only to discover in the roentgenogram a prominent medioplantar border with the medial sesamoid well lateral to it (Fig. 8). Removal of this prominent ridge gives complete and permanent relief from pain. If the medioplantar border of the metatarsal head is exposed, and this area is rounded off at the time of exostosectomy, the prominent ridge will be avoided (Fig. 3, *E*).

3. *Roentogenographic study of these feet showed the following:*

a. The hallux valgus increased in those cases where abnormal anatomical relationship existed between the first and second toes, or in those where the hallux valgus was 50 degrees or over. In these cases, the splay of the foot also increased.

b. If the roentgenogram immediately after operation showed a prominent medioplantar border, subsequent roentgenograms showed the same condition. In no case did a prominent bony ridge develop spontaneously after operation.

CONCLUSION

Simple exostosectomy is a satisfactory procedure for the relief of bunion pain. It has a definite place among the operations for painful bunion. The operation seems to the authors to be most applicable to those people with a mild to moderate degree of hallux valgus, who are beyond the third decade of life, and in whom correction of the hallux valgus is not essential.

THE LOCAL USE OF SULFANILAMIDE IN VARIOUS TISSUES *

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A review of the literature on sulfanilamide is beyond the scope of this paper, but certain facts in connection with this drug should be mentioned. Most of these have been gleaned from the literature and some from our own experience. We believe that the following may be accepted as true:

1. When the drug is administered by mouth or parenterally to man or to laboratory animals it enters the blood stream and is excreted rather rapidly.

2. When sulfanilamide is given in therapeutic doses, the blood of the recipient becomes bacteriostatic for beta-hemolytic streptococci and for certain other susceptible bacteria. As a result, many patients infected with susceptible bacteria recover when the drug is administered. Likewise, laboratory animals treated with sulfanilamide survive lethal doses of susceptible bacteria.

3. Since the drug is excreted rather rapidly, effective treatment requires that the dose of the drug be repeated about every four to six hours and that an adequate concentration (about ten milligrams per 100 cubic centimeters) be maintained in the blood until the infection is eliminated. This means that the drug must be continued for several days after the disease has apparently been arrested, as living but static or dormant bacteria may still remain in the tissues and may begin to grow and reproduce the disease.

4. In therapeutic doses the drug is slightly toxic to most patients and is very toxic to certain patients who are hypersensitive to it. However, it is to be noted that the few fatalities which have been recorded in the literature have occurred rather late in the use of the drug and in patients who have received from 30 to 100 grams of sulfanilamide.

5. The manner in which sulfanilamide acts is not known. It affects the bacteria directly, and does not increase the resistance of the infected animal. Consequently, the drug must come in contact with the bacteria in the animal body.

6. In therapeutic doses the drug is not bactericidal. It merely inhibits the rate of growth of susceptible bacteria which are then eliminated by the natural resistance of the animal. Consequently, treatment of the disease may be rendered more effective by measures, such as immune serum, which increase the resistance of the animal.

* Read at the Annual Meeting of the American Orthopaedic Association, Kansas City, Missouri, on May 9, 1940.

7. The drug diffuses from the blood into the body cavities and into the tissues of the animal. The concentration probably varies in different tissues, but it is less than that present in the blood at the same time.

8. The drug exerts its principal effect on generalized infections and has relatively little effect upon local lesions.

9. The results obtained by the administration of sulfanilamide to infected animals cannot be obtained by exposing bacteria to similar concentrations of the drug in culture media. However, studies of the action of sulfanilamide *in vitro* have shown the following:

(1) The effectiveness of the drug varies in different media and a small amount of peptone or peptone-like substances in the medium greatly decreases the power of the drug. In other words, if bacteria are grown in an unfavorable peptone-free medium and then subjected to low concentrations of sulfanilamide, the action of the sulfanilamide on the bacteria under these conditions may approach that which is obtained by the low concentration present in the blood of infected animals that have received the drug in therapeutic amounts.

(2) The effectiveness of the drug varies directly with the concentration present in the medium and high concentrations of the drug may be bactericidal, especially if the medium is one which is favorable to the action of the drug and is unfavorable to the growth of the bacteria.

(3) The effectiveness of the drug varies inversely with the number of bacteria present and a massive implant of bacteria may grow in a concentration of the drug which would prevent growth of a small inoculum.

(4) When the bacteria are exposed to the drug there is a period of from six to eight hours during which the bacteria continue to multiply before the drug begins to act.

(5) An increase of even a few degrees in the temperature markedly increases the power of the drug, and bacteria which are killed when exposed to a given concentration of the drug at 40 degrees may grow well in a similar concentration of the drug at 37 degrees.

(6) The drug is highly selective and in therapeutic concentrations it has little or no effect upon many pathogenic organisms. However, high concentrations of the drug may inhibit the growth of staphylococci and of Welch's bacilli which are not affected by the concentrations obtainable in the blood of treated animals.

(7) The drug neutralizes the toxins of certain pathogenic bacteria, notably the staphylococcus and Welch's bacillus.

During the past year we have been interested in the local effects of sulfanilamide, both as a preventive of infection in contaminated and clean operative wounds and as a method of treating wounds which are infected.

The local use of the drug was first brought to our attention about three years ago by Knowles[1] who told one of us that he had been injecting neoprontosil solution into the tissues around wounds where he feared gas gangrene might develop and that he had also injected it into the muscles and subcutaneous tissues of wounds in which gas gangrene had developed

following operative drainage or amputation. He said that he had been satisfied with the use of the preparation in this manner. We were also impressed by the results which Jensen, Johnsrud, and Nelson [2] obtained by the local use of sulfanilamide in compound fractures. Making no other change in their technique of débridement, suture, and after-treatment, they had reduced the incidence of infection in compound fractures from an average of 27 per cent. to only 5 per cent. One cannot fail to be impressed by such figures, and we have routinely used the drug in contaminated wounds during the past year. However, we have also used the drug in clean wounds, not routinely, but especially in operations where there was considerable damage to the tissues and where foreign materials, such as bone grafts and wire or screws, were left in the wound. In other words, we have endeavored in certain instances to make our surgery bacteriostatic rather than aseptic or antiseptic, and our clinical results have been satisfactory. However, before using the drug in clean wounds, the following two points should be settled: (1) Should the drug be sterilized before it is placed in the wound, and (2) Does the drug damage the local tissues?

In attempting to answer the first question we placed an excess of the drug in culture media and inoculated this with various concentrations of streptococci, staphylococci, and Welch's bacilli. When these were incubated at 37 degrees centigrade, bacterial growth was inhibited in all of the tubes during the first forty-eight hours, but only the streptococci were killed while the other organisms continued to grow. Consequently, we believe that the drug should be sterilized and we have done this by placing the dry powder in a flask and putting it in the autoclave. This, we realize, is not an adequate sterilization for bacteriological purposes, but it appears to be satisfactory for clinical purposes, where we combine the bacteriostatic action of the drug with the clearing mechanism of the wound in which it is to be placed. A few bacteria may survive and be carried in with the drug, but their growth will be inhibited and the clearing mechanism of the patient will take care of them without difficulty.

In answer to the second question, we first attempted to determine whether or not local implantation of sulfanilamide interfered with the healing of the bone. In a series of experimental fractures in rabbits we were not able to determine that those in which sulfanilamide had been implanted in the wound at the time of the fracture healed any differently from the similar control fractures in the opposite leg of the same animal [3]. However, we have noted in clinical cases that more fluid tended to collect in wounds in which sulfanilamide had been implanted than was usual in similar clean postoperative wounds. This fluid was dark red in color and occasionally drained out through small openings between the skin edges. Usually, however, the skin wound remained closed and the fluid was absorbed.

It thus appeared that sulfanilamide did have some slight deleterious action on the healing of the wound. Consequently, we decided to ex-

periment with a series of animals, implanting the sulfanilamide in various types of wounds and studying these wounds both macroscopically and microscopically in an attempt to determine if it seriously damaged the tissues or interfered with the healing of those tissues. We were especially interested in its effect on the lining of joint cavities and on the articular cartilage. Two series of experiments were performed. In the first experiment, fractures of two ribs were produced in each of twelve rabbits and sulfanilamide was placed in one wound before it was sutured, but not in the other. In the same animal one knee joint was opened and the incision was extended downward to expose the anterior tibial tendon. This tendon was cut and was then sutured with fine silk. Sulfanilamide powder was placed in the knee joint and around the suture of the tendon and the wound was closed with silk. A similar operation without implanting sulfanilamide was performed on the other knee as a control. In two animals the control knee became infected and the experiment had to be repeated. The animals were sacrificed at intervals of from one to fifteen days. The tissues of the joints and ribs were then examined macroscopically and were studied microscopically. In none of the experimental animals were we able to note from our macroscopic examination that the sulfanilamide in the wound had any deleterious effect except possibly to delay the primary healing during the first few days. It was our impression that in the wounds containing sulfanilamide there was apt to be more fluid in the tissues and there seemed to be more bleeding in the tissues after the wound was closed. Apparently the sulfanilamide interfered slightly with the formation of the blood clot, and in some of these wounds in the first few days there was a soft gelatinous clot which was not as firm as were similar clots in wounds which did not contain sulfanilamide.

Likewise, in our microscopic study of the tissues we were not able to detect any constant differences in the two sets of wounds,—that is, we found that healing progressed at about the same rate in the wound into which sulfanilamide had been inserted as in the control wound. There was no difference in the amount or type of callus in the early fractures of the ribs which were studied. All of the wounds contained leukocytes and fibroblasts in approximately the same amounts as did the control wounds for the same period. In the later wounds the scar-tissue formation in the wounds treated with sulfanilamide appeared to be about the same as that present in the control wounds of the same type. We were particularly interested in the changes of the knee joints and in these we found that after our operation there was a definite synovial irritation with blood and exudate in the joint during the first few days. In the vascular and fatty areas of the synovial membrane, the synovial cells were slightly increased in size and number and the subsynovial tissues were slightly infiltrated with leukocytes and round cells, and there was also some dilatation and engorgement of the veins and capillaries near the synovial surface. This occurred even in areas on the opposite side of

the joint from the suture line. However, these changes were no more marked in the joints which contained sulfanilamide than they were in those which did not, and by the end of the tenth or twelfth day the joints had returned to about their normal appearance.

Likewise, in the experiments in which the tendon was sutured, the tendons appeared to unite just as well in the sheaths containing sulfanilamide as in the others.

In a second experiment, we produced operative wounds in muscles, subcutaneous tissues, fasciae, and joints of twelve dogs. Each wound was controlled by a similar one in the opposite leg, but in the experimental wounds a relatively large amount of sulfanilamide powder was placed before they were sutured. These animals were sacrificed at intervals so that we had experimental wounds of from one to fifteen days' duration. Gross and microscopic examinations of these wounds revealed no constant difference in healing between those which contained the sulfanilamide and those which did not. There was, however, the same tendency to excess collection of fluid in the early wounds. The wounds in the muscles treated by sulfanilamide appeared to heal at about the same rate as the control wounds and this was also true of those in the fascia and subcutaneous tissue. Also, the joints of the dogs showed a low-grade inflammatory reaction as did those of the rabbits, and this tended to disappear with the return to approximately normal condition by the tenth or twelfth day. In the dogs the inflammatory reaction was somewhat more apparent, probably because the wounds were larger, but it was no more marked in the wounds which contained the sulfanilamide than it was in those which did not. There was no evidence in any of our animals that the sulfanilamide in the joint had had any deleterious effect upon the articular cartilage.

In order to test further the reaction of the joints to sulfanilamide, we injected saturated solutions of this drug and 5-per-cent. solutions of neoprontosil into the knee joints of a series of rabbits. These experiments were controlled by the injection of normal salt solution into the joint of the opposite knee of each animal. Since the fluid had practically all disappeared at the end of the first day, these experiments were not carried beyond the period of forty-eight hours, but several animals were used with each drug. Here, too, there was slight irritation of the synovial lining cells of the joints,—that is, they were slightly increased in size and number, and there was a small amount of subsynovial infiltration of leukocytes and round cells in the vascular areas in the synovial surface. There was also some engorgement of the capillaries in these areas. However, in these joints also the reaction to the injected fluid was no more marked in the joints with sulfanilamide than it was in the joints into which normal salt solution had been injected, nor was there any evidence of actual destruction of the lining of the joints or damage to the articular cartilage. We used neoprontosil because sulfanilamide is soluble to only about 1 per cent. while neoprontosil can be obtained in 5-per-cent. solution for injection.

We would have liked to experiment with much more highly concentrated solutions of the drug, but could not do so because we were not able to obtain a suitable sulfanilamide derivative which could be used in solution and which was soluble to more than 1 per cent. Some of the newer derivatives, such as sulfapyridine and sulfathiazol, can be obtained as the sodium salts, which are very soluble,—33-per-cent. solutions of sodium sulfapyridine can be obtained for intramuscular injections, but this drug has a hydrogen-ion concentration of about eleven and is so alkaline that it would act as a severe irritant to the tissues. When it is injected intramuscularly in patients who cannot take the drug by mouth, it probably produces small aseptic abscesses in the muscles into which it is injected. Consequently, it would not be suitable for local use in joints.

As a result of our observations we have felt free to implant sulfanilamide at will in clean operative wounds provided the powder was sterile. The powder should be crushed if it is lumpy from sterilization and it should be spread thinly over the surface of the wound after hemostasis has been effected and just before the wound is sutured. Its collection into masses which act as foreign bodies should be avoided. In suturing the wound, dead spaces should be obliterated when possible. Where the wound is to be left open or partly open, as after operations for osteomyelitis, larger amounts of the powder are used. This is also true when it is used as a bacteriostatic agent in treating an open wound postoperatively.

We have also injected saturated solutions of sulfanilamide into infected knee joints and have felt free to inject 5-per-cent. solutions of neoprontosil into infected knee joints. We have not yet arrived at a point where we have placed sulfanilamide in clean knee joints after operations on semilunar cartilages, but we have routinely placed it in hip joints opened for arthroplasties and in other wounds, and have noted no untoward effects. In fact, we have felt much more at ease in the postoperative course of these patients than we would have if we had not placed the sulfanilamide in the wound.

In none of the patients in whom we have used the drug has there been any indication of a toxic effect, nor have we had any infections. Of course we might not have had any infections if we had not used the drug.

It should be mentioned that powdered sulfanilamide in a wound is similar to a test-tube experiment in which a concentration of the drug of approximately 1000 milligrams is brought into contact with any bacteria which may be present in the media. In such concentrations the drug is effective against small numbers of staphylococci and of Welch's bacilli, and against large numbers of streptococci. However, if the number of staphylococci or Welch's bacilli is relatively large, infection may occur. Likewise, the drug is acting in a medium which is favorable to the growth of the bacteria and is unfavorable to the action of the drug, because tissues break down into peptone-like substances. However, since the drug exerts a neutralizing effect on the toxins of both staphylococci and

Welch's bacilli, the amount of tissue breakdown is limited by the presence of the drug. Also, since the drug converts bacteria into a static or non-pathogenic phase in which they do not invade the surrounding tissues and do not multiply, these bacteria are taken care of by the normal clearing mechanism of the animal and are destroyed. When we consider the facts that local infected lesions contain large numbers of bacteria growing in a favorable medium which contains peptone-like substances and that only a relatively low concentration of the drug can be maintained in such lesions, the reason that the systemic administration of sulfanilamide is not very effective against local lesions is obvious.

CONCLUSIONS

1. Sulfanilamide should be sterilized before it is placed in clean wounds.

2. Joints and other tissues which we have investigated tolerate the drug very well.

3. The powder slightly inhibits the primary healing of the wound, but not to such a degree as to contra-indicate its use in clean operative wounds.

4. It may be used repeatedly in open infected wounds and does not seriously interfere with the healing of such wounds.

5. We not only advocate the local implantation of sulfanilamide in contaminated wounds, but we also advocate its use in clinically clean operative wounds where infection is especially to be feared or would be particularly undesirable.

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SULFANILAMIDE AND INTERNAL FIXATION IN THE TREATMENT OF COMPOUND FRACTURES *

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The beneficial action of any bactericidal agent upon pyogenic infection should be evaluated with extreme conservatism since, with or without any form of treatment, virulent infections may subside suddenly by crisis. The virulence of different strains of the same bacteria varies widely, and the defense of the individual against a given organism is unpredictable. A number of so-called cures have been advocated,—among them formalin, silver nitrate, mercurochrome, and gentian violet; these, however, have been proved harmful, of only slight value, or of no value at all. Unusual care, therefore, has been exercised in the evaluation of our results from sulfanilamide therapy in the treatment of compound fractures.

The favorable influence of sulfanilamide therapy on such virulent infections as acute osteomyelitis and acute infectious arthritis, or infections elsewhere through the body, have been reviewed and discussed extensively in the literature. Our experience is confined chiefly to the preventive or prophylactic action of sulfanilamide on infection in compound fractures. Fifty-four cases have been reviewed, including those wherein internal fixation was also employed. Prior to this study it was thought that fairly dogmatic conclusions could be reached. Complete and unbiased investigation, however, has demonstrated that this report must be regarded as a preliminary one, although the evidence is sufficiently favorable to warrant further use of the drug. At the present time, a much larger and more comprehensive series of cases is being accumulated in which sulfanilamide, as well as other chemotherapeutic agents (sulfapyridine and sulfathiazol), are being utilized.

The fractures in the fifty-four patients who received sulfanilamide as a prophylactic measure may be divided into three groups: (1) fresh compound fractures; (2) old compound fractures with a previous infection; and (3) compound fractures with an active draining infection. There were thirty-five in the first group, twenty-eight of whom were observed within the first twelve hours of the injury; consequently, no differentiation is made as to the element of time. In a portion of this series, from fifteen to twenty grams of sulfanilamide crystals were placed directly into the compound wound, and the wound was closed without drainage. After twenty-four hours sulfanilamide was continued by mouth, fifteen to twenty grains every four hours. Blood concentrations were made on the second and third days, and the dosage decreased if indicated. Cultures were not taken from the fresh wounds. Of the ten cases wherein infection developed, cultures revealed staphylococcus aureus in five,

* Read by title at the Annual Meeting of the American Orthopaedic Association, Kansas City, Missouri, on May 9, 1940.

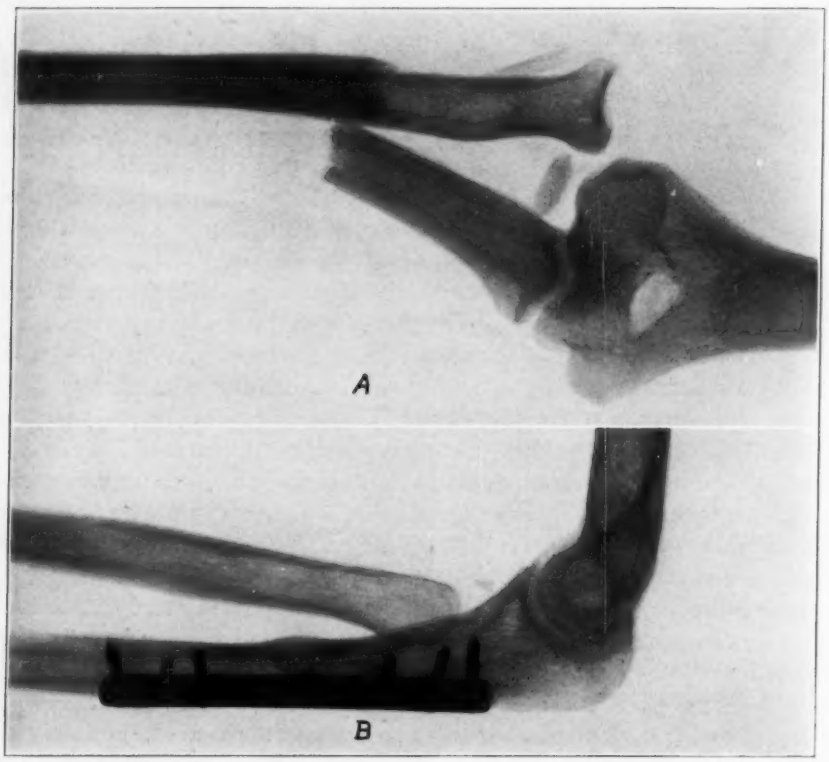

FIG. 1

A. Roentgenogram of a compound fracture of the ulna of moderate degree, with fracture-dislocation of the head of the radius (Monteggia's fracture).
B. Roentgenogram, taken seven months later, shows practically normal function.

Welch's bacillus in three, and streptococcus haemolyticus in one. In one instance the organism was not recorded. These figures would suggest that sulfanilamide had a less favorable prophylactic action upon staphylococcus and Welch's bacillus than upon streptococcic infections.

The second group consisted of seven compound fractures, all of which had been infected, and had eventually healed with malunion or non-union. As these fractures were treated elsewhere, the bacteriological findings of the initial infection were available in only one case,—a combined staphylococcus and Welch's bacillus infection. In such a group one could ordinarily anticipate a flare-up of the infection in a small percentage of cases following extensive reconstruction operations. Sulfanilamide or neoprontosil was administered routinely, the average dose being eight grams of the former or ten grams of the latter, for twenty-four to forty-eight hours prior to the operation, and for three to seven days after operation until there was no longer danger of infection. No infections ensued in these seven cases.

In the third group of fractures surgery was employed in the face of an active draining infection. The dosage of sulfanilamide or neoprontosil

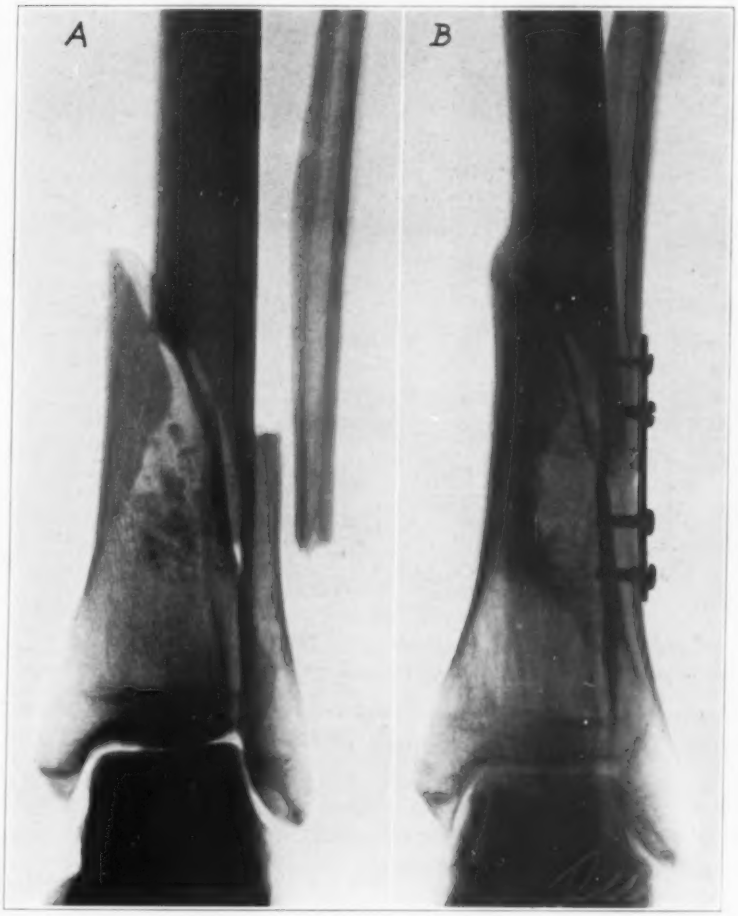

FIG. 2

A. Roentgenogram of a compound fracture of the tibia (severe type) and fracture of the fibula. Injury was sustained by an explosion of a stove. Fibula was plated through separate clean incision. Compound wound was débrided, sulfanilamide crystals placed in the wound, and the skin closed with plastic flap. Primary healing took place. Sulfanilamide was given by mouth for five days.

B. Roentgenogram taken seven months later.

was similar to that administered in the presence of compound fractures with latent infections. The bacteriological studies in this group showed staphylococcus aureus in three cases, staphylococcus haemolyticus in two, and streptococcus haemolyticus in two. The findings in five cases were not recorded.

Prior to the introduction of vitallium, internal fixation by ordinary ferrous metal plates had been attended by so many undesirable and even disastrous complications that the method fell into rapid disrepute. The success of vitallium for internal fixation in selected simple fractures, however, led to the use of the metal in conjunction with sulfanilamide

TABLE I

RESULTS OF TREATMENT IN EIGHTY-FIVE CASES OF FRESH COMPOUND FRACTURES

Results	Sulfanilamide Therapy					No Sulfanilamide				
	Cases				Average Time (*Months*)	Cases				Average Time (*Months*)
	No.		Per Cent.			No.		Per Cent.		
Not infected	25		71.4			33		66.0		
Union		18		51.4	3.1		28		56.0	2.7
Non-union		4		11.4			3		6.0	
Incomplete		3		8.6			2		4.0	
Infected	10		28.6			14		28.0		
Union		4		11.4	2.7		8		16.0	5.0
Osteomyelitis		0		0.0			2		4.0	
Non-union		3		8.6			0		0.0	
Amputation		3*		8.6			2		4.0	
Incomplete		0		0.0			2		4.0	
Died	0	0	0.0	0.0		3†	3	6.0	6.0	
Totals	35	35	100.0	100.0		50	50	100.0	100.0	

* Three patients had amputations for gas gangrene, one died three months later from other causes.

† Two patients died from gas gangrene and one from streptococcic septicaemia.

TABLE II

RESULTS OF TREATMENT WITH SULFANILAMIDE IN MILD, MODERATE, AND SEVERE FRESH COMPOUND FRACTURES

Results	Mild Fractures	Moderate Fractures		Severe Fractures	
	No Internal Fixation	Internal Fixation	No Internal Fixation	Internal Fixation	No Internal Fixation
Not infected	8	6	0	5	6
Union	6	4	0	4	4
(Average time, months)	(3.6)	(2.4)		(3.5)	(3.0)
Non-union	0	2	0	1	1
Too early	2	0	0	0	1
Infected	0	1	1	4	4
Union	0	1	0	1	2
(Average time, months)		(1.0)		(4.0)	(3.0)
Non-union	0	0	1	2	0
Amputation	0	0	0	1	1
Gas gangrene *	0	0	0	0	1
Totals	8 8	7 7	1 1	9 9	10 10

* Patient died three months later from other causes; the gas gangrene had healed.

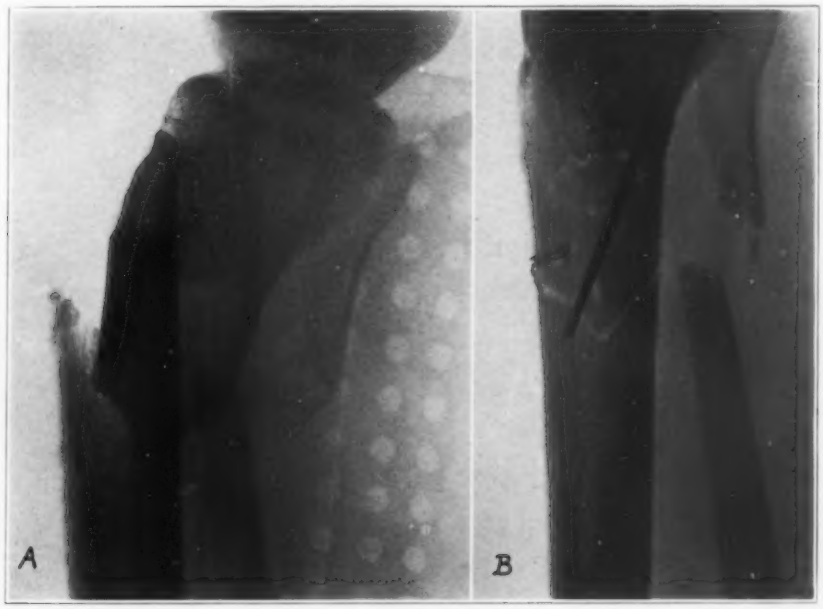

FIG. 3

A. Roentgenogram of a severe compound fracture of the tibia and fibula. Wound involved the knee joint with a six-inch exposure of the tibia.
B. Roentgenogram showing open reduction and fixation by vitallium pin and one stainless-steel wire loop. The wound drained for several months with solid union in six months.

in compound fractures. Some form of metallic internal fixation was applied to thirty-one bones in thirty of the fifty-four patients to whom sulfanilamide was administered. Sixteen of the patients with fresh fractures had internal fixation; eleven of these had vitallium plates and screws; one, vitallium screws; two, stainless-steel nails; and two, stainless-steel wires. Of the seven patients who were found to have potentially infected fractures, fixation by means of plates was employed in three, and bone grafts held by vitallium screws in one. Ten of the twelve patients with actively infected fractures were treated by internal fixation: five, by vitallium plates (two bones were so fixed in one of these patients); one, by stainless-steel nails; one, by stainless-steel wire; two, by Steinmann pins which were incorporated in the cast; and one, by a vitallium screw.

FRESH COMPOUND FRACTURES

In order to evaluate the results of sulfanilamide therapy in fresh compound fractures, a comparative analysis has been made between this group to whom sulfanilamide was administered, and a similar, but larger control group in which this form of therapy was not employed. Unfortunately, we do not have available an older control group in which internal fixation was employed. The results of this study are summarized in Table I.

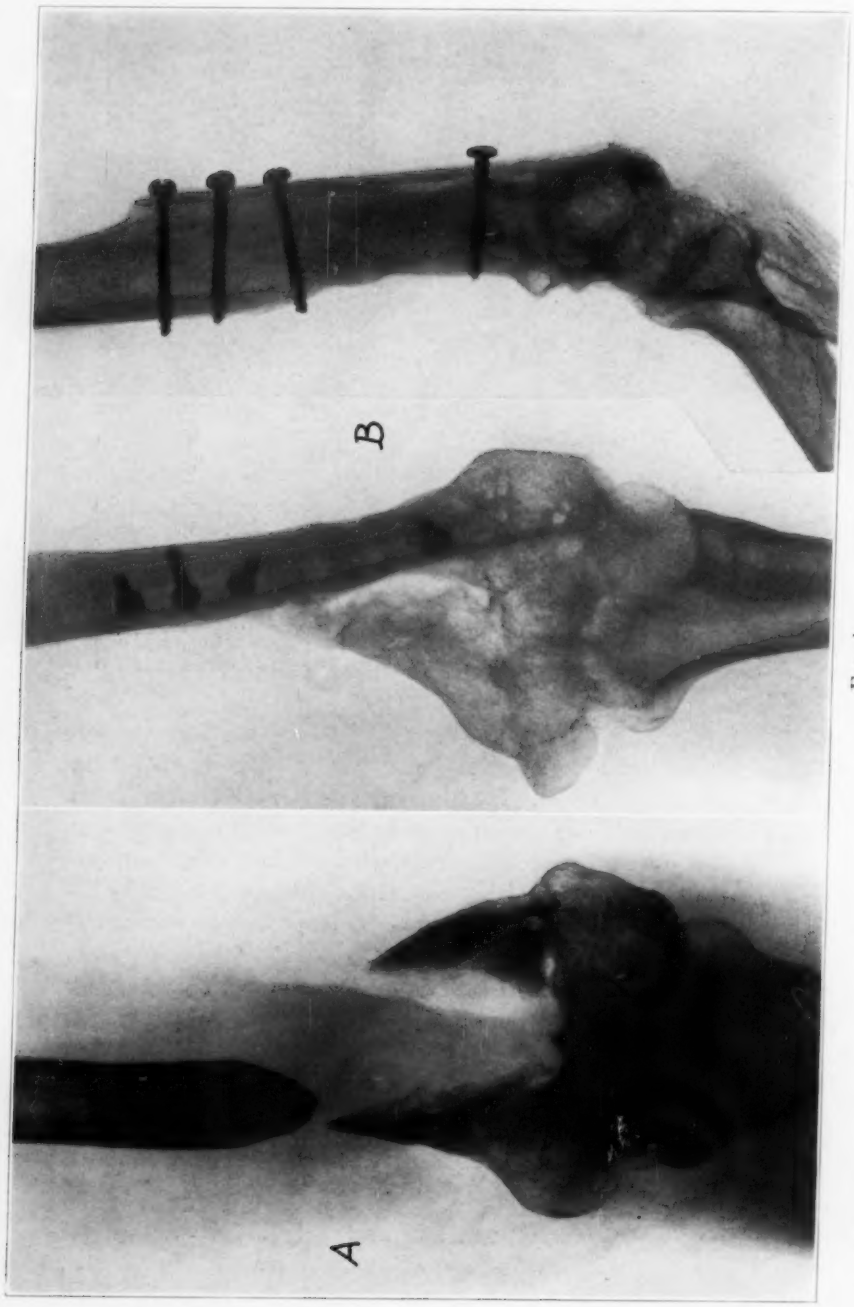

FIG. 4

A. Roentgenogram of an ununited fracture of the humerus of ten months' duration, which was secondary to a compound fracture, and followed by gas gangrene and staphylococcic osteomyelitis.

B. Roentgenograms taken one year and eight months after bone graft which utilized the shaft of the fibula. No flare-up of infection followed the graft. Two screws were removed from the distal portion of graft because of their proximity to the skin surface.

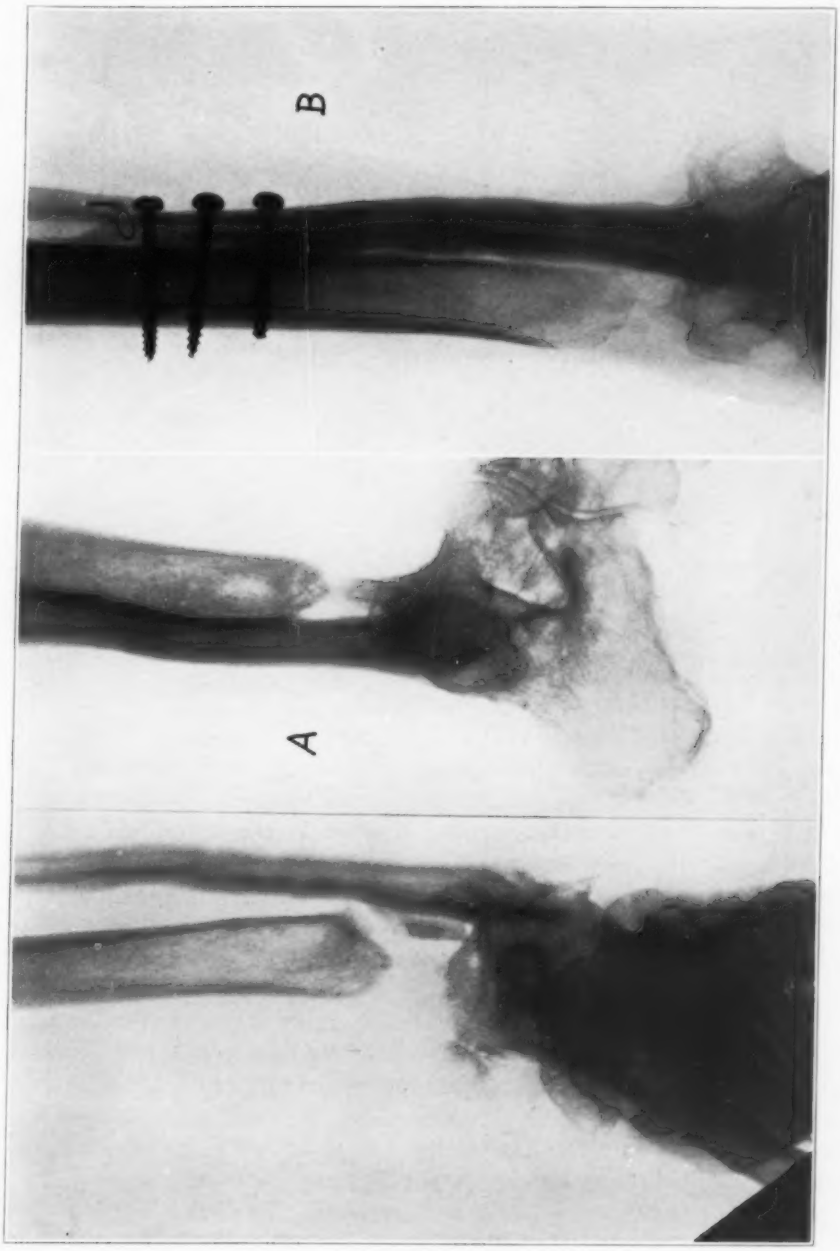

FIG. 5

A. Roentgenograms taken two years after an old compound fracture show loss of lower inch of tibia following osteomyelitis. There was a depressed scar about one inch deep over the defect.

B. Roentgenogram taken after two operations with primary healing in each instance. In the first operation, the old scar was dissected out, and the fibula transferred to the center of the astragalus. This was followed by plastic closure of the skin. The second operation, one year later, transferred the fibula at its mid point to the tibia.

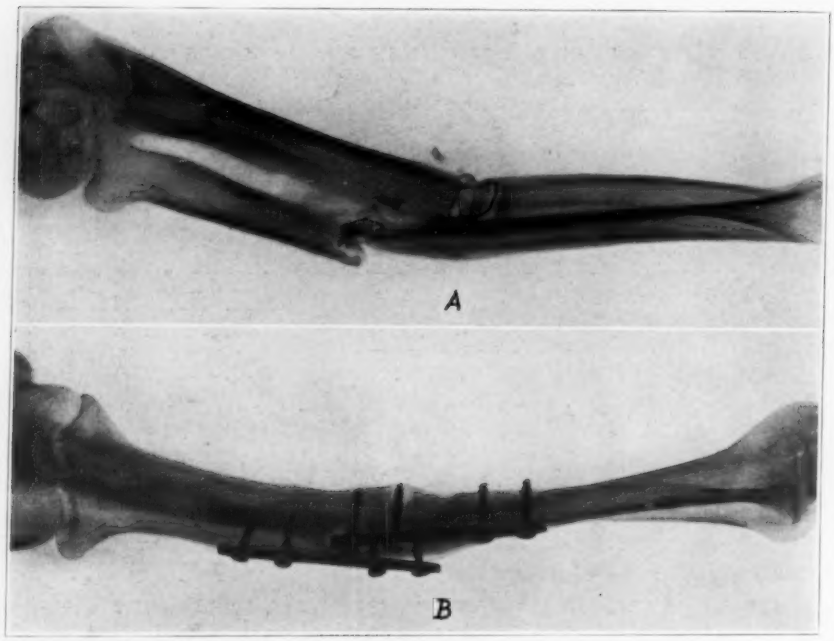

FIG. 6

A. Roentgenogram of a compound fracture with active draining infection and multiple draining sinuses five months after an open operation in another hospital. After preoperative sulfanilamide therapy, sequestra and wires were removed, fractures reduced, and vitallium plates applied. Sinuses healed in four weeks.
B. Roentgenogram taken six months postoperatively.

An analysis of Table I shows that the percentage of infections in the control group and in the sulfanilamide group was approximately the same. The evidence, therefore, suggests that sulfanilamide has little effect on preventing infection. The average period of union in the sulfanilamide group wherein infection developed was two and seven-tenths months, however, as compared with five months in the control cases. This would suggest that sulfanilamide is definitely instrumental in arresting infection, although a much larger series of cases must be assembled before the evidence can be considered at all conclusive. The average time required for union of the uninfected fractures was slightly more than that for the control group. This feature might be accounted for by a possible difference in the character of the fractures in the two groups, or by the fact that internal fixation, which may of itself delay union, was employed freely in those cases wherein sulfanilamide was given. The number of fractures which failed to unite was approximately the same in both groups. None of the patients who received sulfanilamide died as a result of a compound fracture, and in none did osteomyelitis develop; three, however, had amputations for gas gangrene. Of the patients in the control group, three died,—two from gas gangrene, and one from streptococcic septicaemia; and in two osteomyelitis developed.

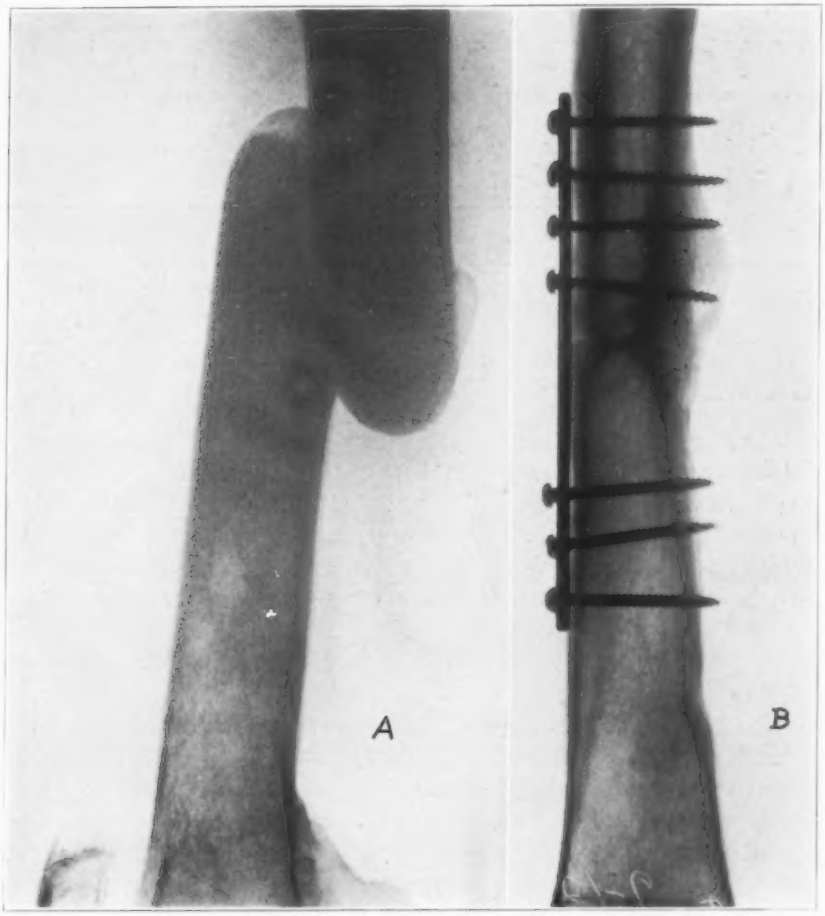

FIG. 7

A. Roentgenogram of a fracture of the femur of seven months' duration, with multiple draining sinuses and large granulating wounds from loss of skin surface over anterior surface of the thigh. Sulfanilamide was administered before skeletal traction, open reduction, and the application of a vitallium plate.
B. Roentgenogram taken eight months later. All wounds had completely healed.

Since the possibility of infection in a compound fracture is commensurate with the degree of laceration and maceration of the soft tissues, the thirty-five fresh compound fractures were further divided into mild, moderate, or severe. Those compound fractures with small wounds from penetration from within by the bone fragments were regarded as mild. No infection developed, no internal fixation was employed, and in six cases union took place in an average time of three and six-tenths months; in two others sufficient time has not elapsed to secure union. Prior to the discovery of sulfanilamide, one could reasonably expect healing of the wound without infection in this type of compound fracture; consequently, a successful outcome did not necessarily indicate a beneficial prophylactic action of sulfanilamide.

TABLE III

RESULTS OF TREATMENT WITH SULFANILAMIDE OF SEVEN CASES OF OLD COMPOUND FRACTURES WITH LATENT OR POTENTIAL INFECTION

Results	Internal Fixation. No Postoperative Infection		No Fixation. No Postoperative Infection	
	Cases	Average Time	Cases	Average Time
Union	3	5 Months	2	3 Months
Too early	1		1	
Total	4		3	

The group of moderate fractures were those in which the laceration was fairly extensive, incident to protrusion of the bone fragments through the soft tissues, but wherein little or no dirt or foreign material had been introduced into the wound. There were eight of these fractures, in seven of which internal fixation was employed with primary closure of the wound. The average period required for union was two and four-tenths months. Three of the fractures failed to unite, in one of which no internal fixation was employed. One with internal fixation became infected, but the fracture united within one month.

The third group, or severe fresh fractures, consisted of those with extensive lacerations, penetrating wounds from without, considerable extraneous foreign material in the wound, and maceration of the tissues which necessitated extensive débridement. Shotgun wounds, with wadding and bird shot in the soft tissues, might cause such fractures. There were nineteen of this type; internal fixation was applied in nine, and conservative methods were carried out in ten. The results are illustrated in detail in Table II.

TABLE IV

RESULTS OF TREATMENT WITH SULFANILAMIDE OF TWELVE CASES OF COMPOUND FRACTURES WITH ACTIVE INFECTION

Results	Internal Fixation. No Postoperative Infection		No Fixation. No Postoperative Infection	
	Cases	Average Time	Cases	Average Time
Union	8	5.3 Months	2	4.5 Months
Too early	2		0	
Totals	10*		2	

* Two bones were plated in one patient, making eleven instances of internal fixation with no infection.

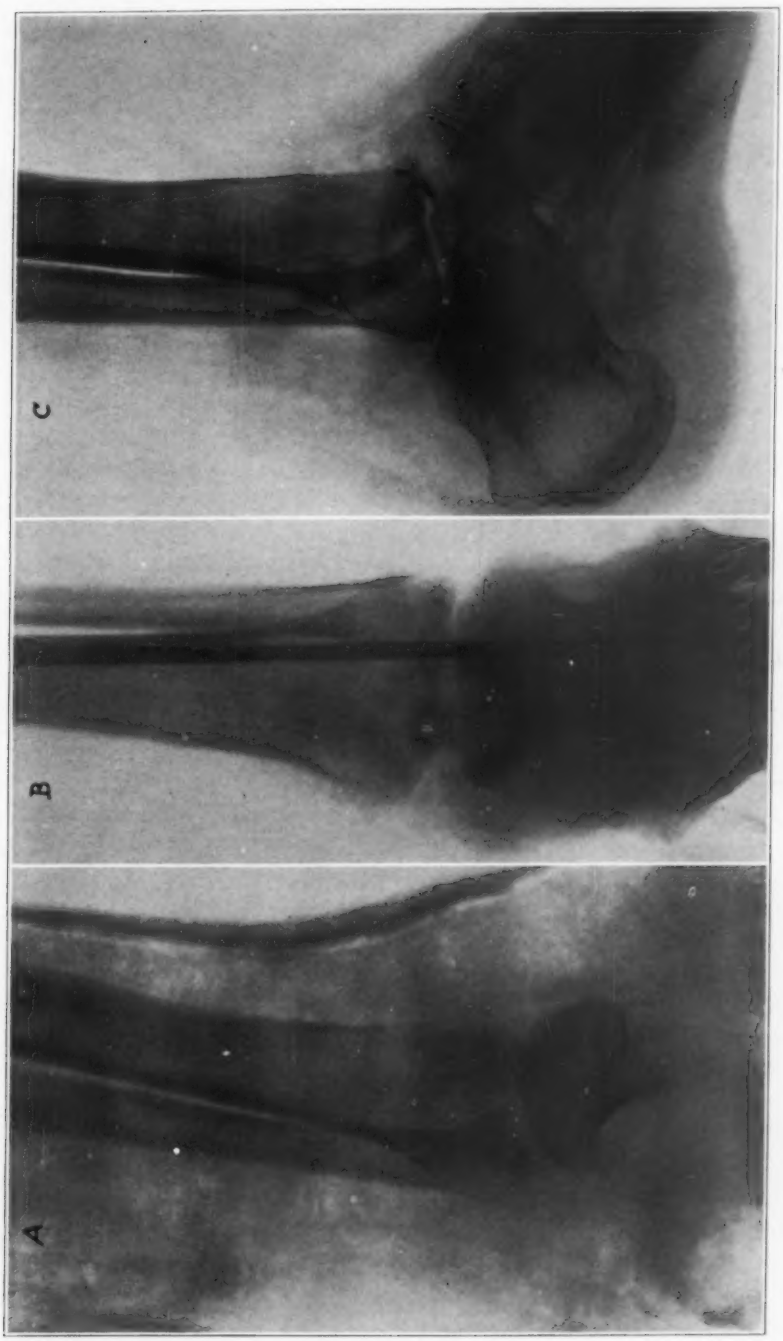

FIG. 8

A. Roentgenogram shows sequestration of astragalus, and loss of both malleoli five months after a compound fracture.
B. Roentgenogram taken after astragalectomy in the face of an active infection. Apposition of the surfaces was maintained by a long Steinmann pin placed through the os calcis into the tibia.
C. Roentgenogram taken six months later. The wounds had healed in three months. There was no motion in the ankle joint, but it was a satisfactory weight-bearing member.

TABLE V

RESULTS OF MAJOR SURGERY WITH AND WITHOUT SULFANILAMIDE THERAPY IN 151 CASES

Results	With Sulfanilamide Therapy				Without Sulfanilamide Therapy			
	Not Infected		Potentially Infected		Not Infected		Potentially Infected	
	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.
Postoperative infection	1	3.0	3	16.7	3	6.0	5	10.0
No infection	32	97.0	15	83.3	47	94.0	45	90.0
Totals	33	100.0	18	100.0	50	100.0	50	100.0

There was little difference in the average period of union between those with and without fixation. The chief advantage of internal fixation lay in the fact that better anatomical alignment could be secured and maintained, apparently without greater risk of the common complications of delayed union, non-union, or infection. Furthermore, less extensive forms of external immobilization could be employed, enabling the soft-tissue wound to be observed and treated more efficiently without fear of displacing the fragments.

COMPOUND FRACTURES WITH LATENT OR POTENTIAL INFECTION

In the seven cases with latent or potential infection, extensive operations were employed,—such as the bone graft for non-union, open reduction and internal fixation for malunion, or reconstruction. In all cases the wounds were closed, and primary healing took place without infection. No control group can be secured from our records, as such radical surgery has not been routinely employed in the past. Often it has been necessary to be content with considerable functional disability, rather than to take the chance of relighting a severe infection with disastrous results.

In three cases internal fixation with vitallium plates was employed; in one, bone grafts were applied with vitallium screws; and in three, no internal fixation was used. Union occurred in five. In two a sufficient length of time has not elapsed to determine the final result. The average period of union in those with internal fixation was five months, while in the two without fixation union took place in three months. This difference may be explained by the fact that more extensive surgery was required for internal fixation, involving an impairment of the circulation secondary to tearing away of the soft tissues.

COMPOUND FRACTURES WITH ACTIVE INFECTION

In this group active infection and draining sinuses, often associated with a mild elevation of temperature, had existed for from three to nine

months. In the presence of active infection, open reduction for malposition with delayed union or non-union, with or without internal fixation, might be considered radical. Draining sinuses were dissected out, sequestra and detritus were removed from about the fracture site, and, following replacement of the fragments, the soft tissues were loosely closed. The results are demonstrated by Table IV.

There were no undue or prolonged febrile reactions following operation. In two of the patients a maximum temperature of 103.6 degrees developed, which rapidly subsided; of these, one had previously had a severe staphylococcus aureus infection, and the other had an old extensive draining gunshot fracture. In both of these cases wide soft-tissue dissection was required for internal fixation. Draining sinuses persisted in a number of cases for several weeks to months, but the wounds ultimately closed, and the bones united. In no case was it necessary to remove any of the plates, screws, nails, or wires. The results secured in these fractures with active infection were the most striking of the entire group in which sulfanilamide was administered. Unfortunately, no control group can be secured for a comparative analysis. It is well known, however, that any effort at radical surgery in this type of case is, as a rule, attended by a relighting of a more serious infection, which defeats the purpose of the procedure. It would seem certain that better functional and anatomical results can be secured in a shorter space of time by these new measures than by the previous routine of long delay while the infection heals. With the bones in poor position, subsequent reconstruction operations are necessary.

PROPHYLAXIS IN CLEAN AND POTENTIALLY INFECTED SURGICAL CASES

In addition to the use of sulfanilamide in compound fractures, we have employed chemotherapy as a prophylactic preoperative measure to prevent postoperative infections in clean major surgical cases. Although infection develops in only a small percentage of clean cases where careful and efficient technique is employed, the great advantage of a reliable prophylactic measure is obvious. Particularly is this true when reconstruction surgery is employed in potentially infected cases, such as those presenting evidence of a former virulent osteomyelitis. There is no more distressing complication in extensive reconstruction surgery than infection. Any measure, therefore, which would prevent pyogenic infection, even though it is of infrequent occurrence, would be a godsend. In thirty-three major surgical cases attended by excessive trauma, and eighteen potentially infected cases, sulfanilamide crystals were placed in the wounds. Although the favorable results were in some cases of a dramatic nature, we do not believe that definite conclusions can yet be reached regarding this prophylactic treatment. A control group of analogous cases was secured from past records and compared with those in which sulfanilamide was used. Table V shows the findings of this comparative study.

Infections developed postoperatively in 6 per cent. of the control cases in contrast to 3 per cent. of those in which sulfanilamide was administered. Of the potentially infected group, the infection was relighted in 10 per cent. of the control group, and in 17 per cent. of the cases wherein sulfanilamide was employed. Obviously, from these figures sufficient evidence is not present to warrant definite conclusions. Although there were 50 per cent. less infections in the clean surgical cases treated with sulfanilamide than in the potentially infected ones, the evidence presented by the control group apparently is not in favor of treatment or prophylaxis by sulfanilamide. Neither the number of cases nor the type of treatment was analogous, however, since with sulfanilamide more extensive reconstruction surgery was carried out in the face of possible infection than had previously been attempted. Nevertheless, a sufficient number of infections did occur to regard with scepticism the prophylactic benefit of sulfanilamide in this group.

CONCLUSIONS

1. The evidence presented does not prove definitely that sulfanilamide either is or is not a preventive of infection in compound fractures. More definite conclusions can be reached only by a comparative analysis of at least 200 cases with a control group of an equal number of analogous cases from past records.

2. Primary healing of mild fresh compound fractures obviously should be disregarded as evidence of any favorable action of sulfanilamide. In the severe and moderate types of compound fractures reported herein, certainly better anatomical and functional results were secured by internal fixation in conjunction with sulfanilamide, without higher proportions of complications, than developed in comparable control groups wherein internal fixation and sulfanilamide were not employed.

3. In seven consecutive cases with potential infection following compound fractures, extensive surgery was followed by more complete restoration of anatomical contour, without relighting of infection, than had been possible in the past.

4. The beneficial influence of this drug was most striking in the group of actively infected fractures in which radical surgery had previously led to disaster.

5. Far too many premature conclusions regarding the beneficial action of bactericidal agents are to be found in the literature. The present impression of sulfanilamide is favorable, but more extensive investigation must be carried out, not only with sulfanilamide, but with other chemotherapeutic agents, before an accurate evaluation is possible.

AMPUTATION AT THE KNEE JOINT *

BY S. PERRY ROGERS, M.D., CHICAGO, ILLINOIS

The surgical operation of amputation at the knee joint is a little more than 100 years old. Its first great exponent was Velpeau, who, in 1830, collected fourteen cases and described an operative technique using a circular cuff closed in the sagittal plane. His collection included the first case recorded in America, performed by Nathan Smith in 1824. Steven Smith added ten American cases to the literature in 1852. Markoe added six additional New York cases in 1856, and claimed eight major advantages for the operation, every one of which is pertinent today. Brinton, in 1868, first distinguished between amputation "at the knee-joint" and "at the knee". The latter term embraced all those procedures in which the condyles were cut, and would now include, along with the Carden operation of his day, the osteoplastic operation of Gritti-Stokes and the tendoplastic operation of Callander. Otis collected 211 knee amputations from the records of the Union Army in the War between the States and found a mortality rate much more favorable than that in amputation through the thigh. Watson published a book on amputations in 1885, praising this site of election and quoting a number of distinguished contemporaries of the same opinion. The terms "disarticulation", "ex-articulation", and "amputation in contiguity" were used to describe "amputation at the knee-joint".

During the past fifty years this site has fallen into neglect and disrepute. It was little used in the World War of twenty-five years ago. Philip Wilson, Huard, Kurts and Hand, Eloesser, and Lee have condemned it within the past decade. The latest handbook of the Association of Artificial Limb Manufacturers of America, dismisses the site as "impeding to successful prosthesis". Two reasons for its decline in the latter part of the past century are negative reasons. With the use of anaesthesia the saving in time seemed less important, and with the advent of asepsis the danger of opening bone marrow and muscle bellies to infection was ignored. Many recent objections have been founded on concern for the leg-maker. The opinion current among surgeons, that an efficient and sightly prosthesis cannot be made for this amputation, is, however, no longer grounded in fact. Other recent objections founded on case reports of tenderness over the "floating" patella and of late atrophy and ulceration over the condyles are explained by fundamental faults in the operation as heretofore performed. Two essential steps in the operation to be described are designed to prevent these two complications.

The author's approach to this problem has been functional, the object

* Presented at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Boston, Massachusetts, on January 24, 1940.

being to create a stump which would function in a manner as nearly like the normal lower extremity as possible.

The primary function is weight-bearing, and the secondary function is locomotion, both of which depend on the relative absence of pain. The only tissues normally subjected to outside pressure are: finely trabeculated cancellous bone, surrounded by a thin cortex, and covered by either hyaline cartilage or adherent periosteum; the tendinous origins or insertions of muscles; secretory pouches such as joint cavities and bursae; areolar connective tissue; and skin—the last two of a congenitally specialized variety. The bellies of muscles and the cortical shafts of long bones are nowhere subjected to pressure. Weight-bearing, opposed to the vertical force of gravity, demands a horizontal body surface, and the larger this horizontal area is, the less pressure is required per unit of surface. Requisite for locomotion is the preservation of the function of muscles remaining in the stump by retaining their natural length and their origins and insertions to bone. Locomotion in a stump demands effective motor leverage and lateral surfaces capable of transmitting such force to a prosthesis. Finally, a prosthesis must be turned and lifted as well as propelled.

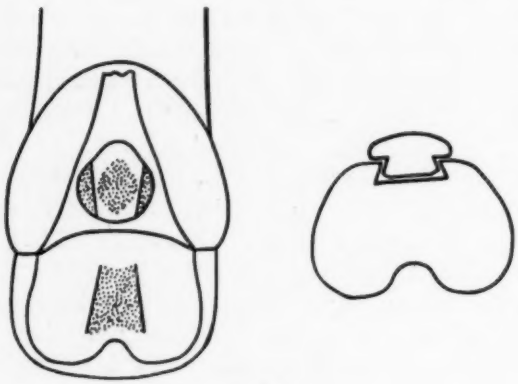

FIG. 1

Diagram of fixation of patella by dovetail mortise. Left sketch shows anterior flap turned up *en masse*, patella dovetailed by undercutting its edges into wedge shape wider at the lower pole (cephalad), mortise undercut into front of femur in wedge shape wider at bottom. Right sketch shows horizontal section of completed dovetail mortise.

The following technique for amputation at the knee joint includes three essential features: creation of a terminal flap from tissues normally subjected to external pressure; fixation of the patella to the front of the femur at a level serving to increase the horizontal end-bearing surface area; and suture of the hamstring tendons to the tip of the patellar tendon in the posterior intercondylar notch. The operating room set-up described by Callander is recommended,—that is, the patient supine, the knee flexed, and the operator on the side opposite the extremity. It allows easy access to the popliteal space through the cleft between the adductor longus and the inner hamstrings. A tourniquet may be omitted. A broad anterior flap extends one inch below the tibial tubercle, and a broad posterior flap one inch below the flexion crease. The length of the flaps depends somewhat on the obesity of the patient and on the healthy tissues available; the object is to cover the condyles snugly. Retraction

of muscles and the consequent need for excessive length of flaps are avoided by attaching all tendons to bone.

Deep dissection proceeds from the inner side first. The tendons of the four inner hamstrings are exposed in order, identified with Allis forceps, and cut low down. The popliteal artery is now accessible, and is ligated just below its superior geniculate branches. The tibial nerve is ligated, injected with alcohol, and cut. The common peroneal nerve may be dealt with in a similar manner at this time or reached from the outer side later. The outlines of the anterior flap are carried through the deep fascia and reflected *en masse*. The patellar tendon is freed as close to the tubercle as possible. Skin, fascia, patellar tendon, and synovial membrane are reflected in one undisturbed full thickness. The tendon of the biceps femoris and the iliotibial band are identified with Allis forceps, and cut low down. The short posterior flap is reflected upward; the lateral and crucial ligaments are cut close to the femur; and the leg is separated from the thigh by stripping the heads of the calf muscles from the femur.

FIG. 2

Lateral roentgenogram of stump, showing patella fused to front of femur, its lower pole forming a third point of bony support in the same horizontal plane with the lower surfaces of the condyles.

Function of all of the muscles motivating the thigh is preserved by attaching all of the tendons under normal tension to the end of the stump. The patellar tendon reaches well back into the intercondylar notch, and may simply be sutured to the ends of the hamstring tendons in that location. However, fixation of the patella to the front of the femur, with its lower pole on a level horizontal with the lower surfaces of the condyles, serves to increase further the size of the horizontal end-bearing surface. To accomplish this fixation a dovetail mortise is recommended, the patellar dovetail being slid up from below and retained by the tension of the quadriceps. As an alternative procedure, the apposing cartilaginous surfaces may be denuded, and the patella fixed with a vitallium nail. The ends of the hamstring tendons, still identified by forceps, are next

FIG. 3

Photograph of stump after one year of function in prosthesis. Note minimum degree of muscular atrophy. Also note triangular and bulbous shape of tip, which is useful in lifting the prosthesis and in controlling its rotation.

FIG. 4

End of stump after one year of function. Note size of end-bearing surface area supported by three bony prominences, and composed of tissues adapted to pressure.

securely sutured to the tip of the patellar tendon. The biceps and three of the inner hamstrings may be so secured, while the sartorius and the iliotibial band may be conveniently sutured to the fascial layer of the edges of the anterior flap.

No excision of synovial membrane, or denudation of synovial cartilage is performed, and no drains are necessary. The flaps are trimmed to fit snugly, and the fascial layers are closed with interrupted catgut, and the skin with interrupted silk. Dry gauze dressings are applied, and a simple pressure pad over the end of the stump is attached by four strips of adhesive tape to the skin of the thigh. No cradle is used to protect the stump from the weight of bedclothes. Pressure exercises, such as stepping on a padded chair, may be started two weeks after operation, and within six weeks the stump should be ready for walking in a permanent prosthesis. A pylon is not recommended.

This amputation presents surgical advantages recognized a century ago and still sound. The avoidance of cutting through bone makes the operation easy and rapid; minimizes surgical shock; and avoids both opening medullary bone to infection, and stirring up fat embolism. By not severing any muscles in their fleshy bellies, paths for infection are not opened up within their sheaths. The resulting stump fulfills the requirements for function in the following ways:

FIG. 5

Prosthesis applied. Note leather socket padded at the bottom, entered at the front, and laced up like a shoe. Elastic harness from pelvic girdle replaces action of quadriceps muscle in extending knee.

FIG. 6

Prosthesis applied, patient sitting. Note that limb is *not* undesirably bulky about the knee, and that the thigh does *not* appear longer than its fellow.

1. It provides the largest horizontal end-bearing surface area available in the lower extremity.

2. The bone, soft tissues, and skin at the end of the stump were all previously adapted to weight-bearing.

3. The terminal integuments subjected to pressure are not subjected to tension.

4. Muscular control of the stump is achieved by preserving the length and attachment of every muscle motivating the thigh.

5. Excellent leverage can be exerted on a prosthesis because the stump is long and because its terminal circumference is both firm and insensitive.

6. The triangular tip, composed of patella and two condyles, assures control of rotation of the prosthesis.

7. The bulbous shape of the tip allows the stump to lift a prosthesis as the foot lifts a shoe.

8. Atrophy is minimized by preserving the function of most of the muscles left in the stump, and by the early use of a permanent prosthesis.

9. Vascularity of the terminal tissues is unexcelled. Ligation of the popliteal artery below its superior geniculate branches leaves the richest system of arterial anastomoses available in the extremity. The greater part of the terminal flap comes from in front of the joint space and therefore already has a blood supply independent of its underlying tissues.

10. Preservation of the lower femoral epiphysis, accountable for 90 per cent. of growth of the femur, allows normal development of the stump following amputation in childhood.

The prosthesis suitable for this amputation must meet certain specifications. The socket should fit the stump snugly to within two inches of the perineum, with allowance for one inch of felt in the bottom of the socket. The diameter of the stump is greater at the condyles than immediately above them; therefore the socket must be entered from the front and laced up like a shoe. The lower third of the socket should be rigid, to prevent the sides from squeezing together when pressure is exerted on the bottom. Side joints must be used, to equalize the lengths of thigh and leg. The prosthesis may be used without harness, but elastic straps from a simple pelvic girdle to the outer side of the thigh socket and to the front of the shin piece serve to increase stability and to quicken the step.

Summaries of twenty-three amputations in twenty-two patients are available for analysis. For twenty operations the author is directly or indirectly responsible. In seven of these the technique described was followed exactly, and in the remainder it included at least two of the three steps indicated as essential. All were performed between April 1933 and November 1939. The ages of the patients ranged from six to seventy-three years; eight were under twenty and four were past sixty. Analysis of the causes for amputation shows a preponderance of operations performed for the relief of chronic disability. Only four were primary amputations following severe trauma. One was for osteogenic sarcoma of the tibia. Five were necessitated by vascular disease; two for arteriosclerotic gangrene, and one each for thrombo-angiitis obliterans, diabetic gangrene, and polycythaemia vera. Thirteen were done to relieve patients of hopeless deformity, congenital or post-traumatic, or of intractable bone infection. Four were reamputations.

There was one death in the series,—a forty-year-old man, whose stump had healed by primary intention, died of streptococcus septicaemia eight days after his second reamputation for chronic osteomyelitis. Minor sloughs occurred in three suture lines,—in two because the flaps were cut too short in obese patients, and in the other because of old scar tissue in the flaps. Late complications of a minor nature developed in three cases. Ulceration over one of the condyles developed in one case because of old scar tissue previously deprived of its sensory nerve supply, and in another case in which the hamstring tendons were not anchored. Recurrent tenderness over the patella developed in one case in which the patella was not anchored. Excluding the one death and two elderly patients oper-

ated on less than three months ago, every one of the remaining nineteen patients has been able to use a prosthesis successfully. Eight used pylons for short periods. Five walked on some kind of prosthesis one month after amputation, and five more used prostheses within two months. The problem has been to obtain artificial limbs rapidly enough, rather than to prepare the stumps for their use. One patient does manual labor on bilateral prostheses. Another patient, with a satisfactory amputation on the opposite side at the recognized site of election in the leg, considers the side amputated at the knee joint his more serviceable extremity. In all cases more than six months old, three-fourths of the patients have returned to occupations as strenuous or more strenuous than those pursued previous to amputation. All the six patients under fifteen years of age have demonstrated continued growth of their stumps without atrophy or ulceration of the terminal integuments.

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INJURY TO INTERVERTEBRAL DISCS DURING SPINAL PUNCTURE

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Routine diagnostic spinal puncture is generally regarded as a rather innocuous, though moderately uncomfortable, procedure, and probably is, in the vast majority of cases. Considering the number of punctures performed annually by individuals of varying experience and skill, and the paucity of reported complications incident thereto, one is led to believe that spinal tapping is indeed relatively free from danger. Occasionally local accidents, such as the breaking of a needle after entry, are worrisome. The advent of any degree of infection is always a perilous sequel. So-called dry and bloody taps are usually ascribed to ineptness on the part of the operator,—and promptly forgotten. Yet, according to Pease, even following a successful puncture, many people complain of pain in the lower back and little significance is attached to the origin of this complaint. It is dismissed as a necessary inconvenience.

As a matter of fact, Pease, in performing lumbar punctures on cadavera, learned that he could not always determine when the point of the needle was actually in the neural canal or past it, even when it struck the intervertebral disc and penetrated it (Fig. 1). Experimentally he found that the most common sites for the final landing-place of the instrument when pushed beyond the neural canal were: (a) intervertebral discs, (b) vertebrae, (c) interarticular facets, and (d) venous sinusoids in the vertebral body. Levinson listed as one of the causes of a dry tap, introduction of the needle so far beyond the spinal canal that the intervertebral disc was punctured and the needle clogged with nuclear material exuding therefrom. This obviously injures the structure of the disc. This fact is to be borne in mind in evaluating the case that is herewith reported.

Keyes and Compere proved that: (1) if the cartilaginous plate of the intervertebral disc of the dog is injured by a scalpel or drill, the nuclear material prolapses into the spongiosa of the vertebral body, and a cartilaginous nodule forms; and (2) if nuclear material is allowed to escape, the rest of the disc becomes thinned out and the edges of the adjacent vertebrae become sclerosed with subsequent marginal lipping. This work gives support to the findings observed in this case, and those of Milward and Grout. These authors reported five cases of back trouble starting from within a few moments to six months following spinal anaesthesia. Roentgenographic investigation revealed progressive arthritis localized in one intervertebral joint, loss of joint space, and new bone formation linking up articular edges of the bodies of adjacent vertebrae. Pease in 1935

presented three cases of intervertebral-disc injury following lumbar puncture with convincing clinical, roentgenographic, and experimental evidence to support the views that appear in his article.

Geist, Calvé and Galland, Sashin, and Beadle have enumerated a number of pathological conditions in which the intervertebral nucleus pulposus is either primarily or secondarily involved. Keyes and Compere in a comprehensive paper have elected to classify the various lesions according to the primary location of the pathological process, but admit it is obvious that there must be some overlapping, in the following three groups: (1) pathological conditions of the nucleus pulposus; (2) pathological conditions of the cartilage plates; (3) pathological conditions of the vertebral bodies.

FIG. 1

Roentgenogram. Dr. Louis J. Kolodner has demonstrated on a cadaver the ease with which a spinal-puncture needle may be inserted directly into the intervertebral disc.

Although these three main groups are further subdivided into eleven sections, each briefly discussed, no mention is made of the injudicious use of the spinal puncture needle as a possible cause of acute trauma to the components of the intervertebral disc. Compere, however, in discussing Pease's paper on this subject, admitted that such a situation is by no means inconceivable.

The following case is presented in the belief that it is one in which the second and fourth lumbar intervertebral discs were traumatized during spinal puncture in a manner analogous to the experimental injuries described by Keyes and Compere. Similar resultant pathological changes in the vertebrae are revealed by comparative roentgenograms over a period of many months.

CASE HISTORY

D. S., a fourteen-year-old white girl, has been known to the Sinai Hospital Out-Patient Department since October 4, 1932, when, at the age of seven, she was brought there for a complete examination. Her father had died at thirty-three of general paresis, and her mother and brother were being treated for general paresis and congenital syphilis, respectively. The past history indicated that when the girl was nine months of age, she had convulsive seizures which terminated in a right-sided hemiparesis. This gradually, though not completely, cleared during her early childhood.

The patient received adequate antiluetic treatment while under observation. On June 20, 1936, a routine spinal puncture was performed without any difficulty. Her first admission to the hospital was on July 7, 1936. Between this date and August 16, 1936, she successfully and satisfactorily weathered ten paroxysms of induced tertian malarial fever. She was, thereafter, again followed in the dispensary.

On September 4, 1937, three fruitless attempts at spinal puncture at several lumbar levels resulted in an immediate and continuing complaint of local pain which was severe enough for the next few weeks to make her spend most of her time in bed, except when she was transported to and from the clinic. On September 8, 1937, x-rays were taken and read as negative (Fig. 2). As home rest proved ineffective, she was admitted to the hospital on September 27, 1937.

When first seen in the ward, the child was apparently in so much discomfort that a satisfactory examination could not be made. The lumbar spine was held in a position of marked hyperextension. The slightest passive movement of the head, neck, or lower extremities was sufficient to provoke additional spasm and pain. There were a number of pin-point puncture wounds in the skin of the lumbar region.

The known history that a previous spinal tap had not been followed by such severe complaints naturally led to the suggestion that there was a direct causal relationship between the dry taps and the immediate response in the lower back. Since it was noted within a few days that the temperature was elevated to 101.2 degrees, local infection of the epidural tissues was considered as a diagnostic possibility along with traumatic periostitis and intervertebral-disc pathology.

Under rest on a Bradford frame and mild sedation the child became more tractable. A more complete physical examination revealed a right-sided ankle clonus and a suggestive positive Babinski response which were regarded by Dr. I. J. Spear as residual evidences of the old aforementioned cerebral affection at nine months of age.

Within one week the local pain subsided and the extreme lumbar lordosis slowly receded, the spine assuming its natural contour. A convex frame was then employed, but in spite of this form of support and enforced recumbency, on October 13, 1937, about five weeks after the puncture, prominence of several lumbar spinous processes was noted. Gradually there developed a general posterior bowing of the lumbar spine with a noticeable kyphos at the level of the second and fourth lumbar vertebrae. On October 22, 1937, an uneventful spinal puncture was made. The total proteins were within normal limits, the Wassermann reaction was still positive, and the colloidal gold test showed activity in the paretic zone. No trouble, such as had followed the tap of September 4, 1937, was encountered. On November 1, 1937, a plaster jacket was applied with the lumbar spine in extension. This was later replaced by a spinal corset which was worn for more than a year. When this was finally removed, no local symptoms were noted. The back moved freely but the knuckles at the second and fourth lumbar spinous processes were still present with no appreciable increase in size.

A series of roentgenograms taken at varying intervals from September 8, 1937, four days after the onset of difficulties, to April 27, 1939, a period of nineteen and one-half months, demonstrated the changes that took place in the intervertebral discs and the adjoining structures.

The first set on September 8, 1937 (Fig. 2), as mentioned, were negative for any significant changes. Those on October 5, 1937 (Fig. 3), one month after the puncture,

FIG. 2

Roentgenogram, September 8, 1937, four days after spinal puncture shows no demonstrable defect. (Dark area at antero-inferior portion of the body of the fourth lumbar vertebra is gas.)

FIG. 3

Roentgenogram, October 5, 1937, one month after spinal puncture, shows widening of the intervertebral spaces between the second and third, and fourth and fifth lumbar vertebrae; narrowing of the space between the third and fourth lumbar vertebrae; and roughening of the inferior border of the body of the third lumbar vertebra.

FIG. 4

Roentgenogram, April 27, 1939, taken over a year and a half after spinal puncture, shows irregularly circular, punched-out areas, surrounded by a zone of sclerosis in the bodies of the first, second, third, and fourth lumbar vertebrae.

showed a suspicious narrowing and roughening of the joint space between the third and fourth lumbar vertebrae with a relative widening of the spaces between the second and third, and fourth and fifth lumbar vertebrae. On May 26, 1938, eight and one-half months after the onset, the first demonstrable defects were noted in the adjacent margins of the bodies of the first and second, and third and fourth lumbar vertebrae. These defects, easily visible in all subsequent x-rays until the last, taken on April 27, 1939 (Fig. 4), have remained unchanged in shape, structure, and location, and stereoscopically represent small, irregularly circular, punched-out areas surrounded by a zone of sclerotic bone.

It is felt that the defects shown in the roentgenograms of this case are so-called "Schmorl bodies". Similar areas, when subjected to pathological section, have proved to be a cartilaginous ingrowth from the disc structure to the substance of the vertebral body. These areas were described by Schmorl in 1937 when he reported that 37 per cent. of 7,000 spines which he routinely sectioned showed prolapses of disc material into the spongiosa of the adjacent vertebral bodies.

Pease in his paper referred to the anatomy of the intervertebral unit as consisting of (a) superior and inferior cartilaginous plates, (b) the annulus fibrosus, and (c) nucleus pulposus. The annulus fibrosus is thicker anteriorly than posteriorly. This difference, together with the close union with the anterior longitudinal ligament, makes the disc much stronger and more powerful in front. The nucleus pulposus is a translucent, semigelatinous fluid under considerable pressure, through which are interspersed fine fibrous strands. This fluid occupies considerably more volume in the young, and gradually becomes more firm and solid with advancing age. On flexion (the position assumed during spinal tapping of the spine) the pressure within the disc increases as the anterior portions of the bodies come in closer approximation, causing a slight bulge of the disc and its nuclear material posteriorly. A needle puncturing the nuclear portion of this disc permits the material to escape. Pease has clearly demonstrated this on cadavera, and shown by roentgenograms, taken before and after deliberate introduction of a needle into the disc, a definite narrowing of the disc and intervertebral space, with a compensatory widening of the neighboring spaces. When this nuclear material is extruded through a crack, or other defect in the cartilage plate, into the spongiosa of the vertebral body, an invasive reaction is set up in the bone. The semifluid material is transformed into a cartilaginous nodule (Schmorl body), and the bone about it becomes sclerosed, forming a secondary line of defense to wall off the foreign material. Until sufficient time has elapsed following the prolapse of the nuclear material of the disc for the reaction in the bone to take place, roentgenographic diagnosis usually cannot be made. When the nuclear material is allowed to escape, but does not percolate into the adjoining vertebral body, the rest of the disc becomes thinned out and the margins of the adjacent vertebrae become sclerosed with subsequent marginal lipping.

It is believed that in this particular instance the plates demonstrate (1) narrowing of the joint space (Fig. 3), (2) compensatory widening of the

adjoining spaces (Fig. 3), and (3) Schmorl bodies (Fig. 4). Late sclerosis and marginal lipping of the vertebral bodies have as yet not developed.

SUMMARY

Herewith is presented the case of a syphilitic girl, aged fourteen, whose spine was first punctured on June 20, 1936, without any untoward effects. On September 4, 1937, she was subjected to several unsuccessful spinal taps. These were followed by immediate clinical manifestations of some local disturbance at the site of these taps. Lumbar hyperextension and severe pain were replaced within five weeks by lumbar flexion and prominence of the spinous processes of the second and fourth lumbar vertebrae. Roentgenograms on September 8, 1937, were read as negative for bone pathology, but, as time went on, subsequent plates from October 1937, until the final date of observation in April 1939, gave evidence of narrowing of the affected joint spaces, compensatory widening of the adjacent joint spaces, and the development of the characteristic interarticular, intra-osseous Schmorl's nodules which are generally regarded as pathognomonic of intervertebral-disc disturbance. The entire succession of events in this case is so direct and clear that it is difficult to escape the conclusion that the described end results followed the misadventurous spinal puncture.

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HYDATID CYST OF THE BONE

A Case Report

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Hydatid cysts have been described by medical writers since the earliest times. The character of the growth was determined in 1782 by Goeze[6] who noted the similarity between the microscopic projections from the inner surface of the cyst and the heads or scolices of the adult tapeworms of the Taenia group. He established the fact that the growth was the larval form of a cestode which he named Taenia granulosa.

The adult is a tapeworm 3 to 6 millimeters long which inhabits the small intestines of several animals, most frequently of the dog. Viable eggs, passed in the feces, are easily transferred to other animals. Almost any mammal can be infected by the ingestion of the ova. The eggs hatch in the duodenum or jejunum of this intermediate host. The larvae migrate through the intestinal wall, enter the venules, and are carried along by the blood. Many of these larvae become caught in the capillary filters where they develop into hydatid cysts (Fig. 1).

Experimental investigation by Dew[2] has shown that there is an immediate cellular response to the presence of the larva. During the two weeks following infection the parasite becomes encysted in a cavity usually filled with a clear fluid. Three zones can be distinguished in the wall: on the inner surface the parasite is surrounded by endothelial cells with an occasional giant cell and eosinophils arranged somewhat radially; around this is found a concentric layer of fibroblasts and leukocytic cells; and peripherally there is a zone of degenerated cells of the host tissue which grades into the normal substance. As growth continues the pressure causes the outer layers to become laminated. From the inner wall, the portion infective for the definitive host, brood capsules arise which in turn produce the scolices.

In the case of hydatid cyst of the bone, the parasite has only a partial envelope. With the growth of the larva, pressure on and occlusion of the small arteries finally bring about necrosis. This leads to the breaking down of the bone, and the formation of caseous debris. As this continues, local weakening of the bone occurs, and often results in spontaneous

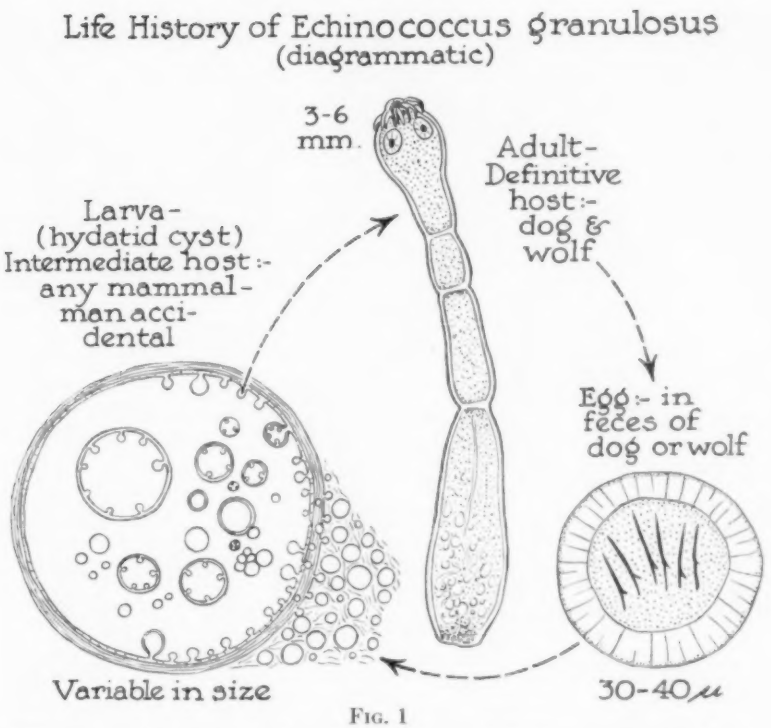

FIG. 1

Diagrammatic representation of life history of Echinococcus granulosus. Eggs produced by the adult worm are passed in the feces of the definitive host. These enter the intermediate host in contaminated food or water. The eggs hatch and the larvae pass to various parts of the body where they develop into hydatid cysts which vary in size from a few millimeters to 15 centimeters or more in diameter. (Adapted from drawings by Prof. E. C. Faust in Human Helminthology, Philadelphia, Lea & Febiger, 1929.)

fracture. A complete discussion of the manner in which the hydatid cysts affect the bone can be found in the work of P. Larghero-Ibarz[9] and Oscar Ivanissevich[7]. According to Dew[4], 76.6 per cent of human echinococcus infections are found in the liver, the first filter encountered. The larvae may pass this barrier and be stopped by the lungs, but, carried beyond this filter, they may enter any organ or tissue of the body. The bones are invaded in .9 per cent of the cases.

Something over 480 cases of echinococcus disease have been reported from the United States, nineteen of which were infected in this country. Magath[10] suggested that the others were brought in as "unseen baggage" by immigrants from countries where the disease was endemic. Of all the cases reported, five were echinococcus infection of the bone: Woods[14]; Walker and Cummins[13]; Stone[12]; and Coley[1] (two cases). This is a report of an additional case. The birth place of the sailor described by Woods[14] was not mentioned. All the other patients, including the one under discussion, were born in countries where the disease is prevalent.

FIG. 2

Roentgenogram taken on admission to the Dispensary, January 21, 1937.

CASE HISTORY

A Polish housewife, fifty-five years of age, was transferred from the Surgery Department to the Orthopaedic Dispensary on January 21, 1937. Her chief complaint on entrance was pain in the left hip. The history elicited the fact that in September, 1936, she had fallen on a waxed floor and injured her left hip. A roentgenographic examination made at this time was reported negative. After six weeks in bed she was able to walk, but was limited in her activity by severe pain in the region of the ilium.

On December 31, 1936, she again fell, this time injuring the same region to such an extent that she was compelled to remain in bed, until January 21, 1937, when she came to the Dispensary. The Dispensary physician, finding pain on motion in all directions of the hip joint, made a tentative diagnosis of arthritis.

Roentgenographic Findings: Figure 2 was taken at the time of admission to the Dispensary. The x-ray made of the pelvis in the anteroposterior direction showed irregular decalcification involving most of the left ilium. It extended upward from the acetabulum to the crest, limited medially by a narrow zone of normal bone with an irregular line of demarcation. Several linear radiolucent areas extended through it which suggested pathological fractures. Coarse trabeculation in the region of the anterosuperior spine suggested giant-cell tumor as the primary lesion, but sarcoma, metastatic malignancy, and myeloma deserved consideration in differential diagnosis. (Practically the same possibilities are suggested by Faust [5] in his discussion of the diagnosis of hydatids of the bone.) The patient was admitted to the hospital primarily for biopsy.

Operative Findings: An exploratory operation of the left ilium was performed on February 4, 1937. A Smith-Peterson incision was made. After the skin had been reflected, a bulging mass appeared in the subcutaneous fat tissue. As this was cut, an appreciable amount of yellow, frothy material gushed out which looked like vaseline that had been mixed with air. When the opening was enlarged, a cystic cavity about two inches in diameter was disclosed which extended through both tables of the ilium.

More of this yellow material was found in this pocket. After a large-sized piece of bone had been removed, the cavity was seen to extend downward and anteriorly into the roof of the acetabulum and the pubic ramus. The material taken from this region was very different in character. Here were found many small gray-white, definitely circumscribed, cystic masses ranging from .5 to 1.5 centimeters in diameter. These small bodies were stuck together with a mucilaginous substance. As far as was possible all these cysts were removed (Fig. 3), but undoubtedly some were left in recessed pockets.

The fracture seen in the roentgenogram made the whole crest of the ilium freely movable. It was not considered advisable to dissect more of this material or sacrifice more of the ilium until a positive diagnosis was made. The wound was closed in layers, and a dry dressing applied. Because of the weakness of the acetabular roof, the leg was placed in traction and kept so for four weeks.

Subsequent Care: The wound healed by primary union. Some pain persisted on motion of the hip joint and on weight-bearing, so the patient was cautioned not to walk without the aid of crutches. The patient has returned to the Dispensary about every two months for observation. Roentgenograms have been taken at various times, the latest (Fig. 4) on April 14, 1939.

She was last seen in the Dispensary on October 11, 1939, at which time she was walking without crutches, but showed a rather marked limp. The pain in her hip was not severe though annoying when she remained standing for any length of time.

Laboratory Findings: Gross examination of the material removed warranted a tentative diagnosis of hydatid cyst. For confirmation, the fluid from some of the cysts

FIG. 3

Hydatid cysts removed during operation on February 4, 1937.

was examined for scolices or hooklets. None were found. (Dew [2] stated that most hydatid cysts of the bone are unproductive of scolices until they reach a cavity large enough for the accumulation of considerable fluid.)

Histological sections of several cyst walls were made. These showed an inner surface of epithelium with certain areas surrounded by fibrous tissue, some of which

FIG. 4

Roentgenogram taken two years after operation, April 14, 1939.

showed concentric ring formation. This constitutes the poorly formed, outer, laminated layer, characteristic of osseous hydatid cysts.

A complement-fixation test gave a reaction of two plus. (Kellaway and Fairley [8] reported that 50 to 60 per cent. of hydatid cyst cases give a positive complement-fixation reaction before the first operation. A reaction of either one plus or two plus is specific and diagnostic. If the reaction is still positive nine months after operation, secondary cysts are undoubtedly developing.)

A Casoni test or skin-sensitivity reaction was also carried out. This was done more for general interest than for need of further confirmation of the diagnosis. Sheep-hydatid fluid was obtained from the United States Meat Inspection Department. This was filtered, and .2 cubic centimeters injected intracutaneously. An oedematous area about the point of injection reached its maximum of 7 centimeters at the end of two hours. This was surrounded by a 4-centimeter area of erythema. Controls made with both saline and normal sheep serum were essentially negative. (According to Kellaway and Fairley [8] 75 per cent. of patients with hydatids give a positive skin reaction preoperatively. This reaction persists for years.)

DISCUSSION

The development of all hydatid cysts is a slow process. When such growth takes place in bony tissue, its progress is so retarded by the obdurate structure that years are required before it manifests itself. Dew [3] stated that in the majority of cases, infestation occurs in childhood. Frequently, as in this case, injury precipitates the immediate symptoms. Faust [5] suggested that external trauma may provide a weakened site for the parasite to grow or accelerate a latent infection.

This patient kept a goat and a dog although she did not have the latter at the time of her illness. The extent of the growth would indicate, however, that she had acquired the disease as a child in Poland rather than from recent contacts with these animals.

Certain cases of human echinococcus disease are known to have been acquired in the United States. Although dog infestation is high in areas where it is endemic, Riley [11] stated that only once, in 1892, has a dog in the United States been proved infected. However, domestic animals in certain regions have been shown to have up to 20 per cent. larval infections. Riley [11] found hydatid cysts in the lungs of six out of thirteen mature male moose in Minnesota. When these cysts were fed to dogs, large numbers of adult tapeworms developed. Two out of three wolves examined from the same region harbored the adult form of echino-

coccus. Apparently the danger is from wild life which accidently spreads the infection to domestic animals. Wild berries contaminated by infected fecal material may be another means of transmitting the disease.

Although hydatid disease of the bone occurs but rarely in the United States its possibility should be considered when pathological conditions of the bone are encountered.

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SLIPPING OF THE UPPER FEMORAL EPIPHYSIS *

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It is not the purpose of this paper to cover the entire subject of the treatment of slipping of the upper femoral epiphysis, or, for that matter, to quote from the rather extensive literature now available; but through the presentation of a small group of cases, to call attention to some points in the pathology and progress of the condition, and to sound again a note of conservatism in the treatment of the early cases. The divergence of opinion in regard to the treatment would in itself seem to indicate that a satisfactory method, universally applicable, had not yet been found. Wilson[8], in an excellent article, calls attention to a number of methods of treating the very early cases, with minimal slipping, which, if the slipping were arrested, would give very satisfactory results. He cites valid objections to each of these methods. The use of the Smith-Petersen nail, suggested by him, is open to the criticism that, simple as the procedure is, it involves two open operations, as well as foreign-body fixation. It would seem that, if equally good functional and clinical results could be obtained by a less hazardous method involving only a good plaster technique, such a method would be generally more acceptable.

This series includes only early cases. There are eight cases, taken from the Services of Dr. Rushmore at the Long Island College Hospital, Dr. Kleinberg at the Israel Zion Hospital, and from the author's private practice. Of the eight cases, six were in the so-called preslipping stage and two had acute injuries with complete disruption of the epiphysis during the course of a gradual slipping.

Of the entire group, six were males, and two females. All but one exhibited a tendency to excessive weight, and the male cases seemed to fall into the endocrine dysplasia group with retarded gonadal development. All were treated by manipulation under anaesthesia followed by a plaster spica, applied according to the technique described by Kleinberg [5], and employed as an ambulatory device. Ambulation was possible to an excellent degree in every case.

In the first six cases with minimal changes in the relationship of the head and neck, the histories were quite uniform. Symptoms were present for three to eight weeks, and consisted of a limp and slight to severe pain, ordinarily relieved by rest. The pain usually radiated down the thigh to the knee, though in some instances, the knee alone was complained of. In one case, strangely enough, pain was worse after resting and relieved by activity. Physical examination of the hip was characterized by limitation of abduction, internal rotation, and flexion. X-rays showed a loss of the overhanging superior lip of the epiphyseal cap, and a broadened, irregular epiphyseal line (Figs. 1-A and 2-A).

* Read before the Orthopaedic Section of the New York Academy of Medicine, on March 17, 1939.

These cases were treated by manipulation under anaesthesia. The hip was manipulated into forced flexion, and then brought into a position of extension, with marked abduction and internal rotation. In this position, a spica was applied. The patients remained in the hospital only long enough to be x-rayed, and taught to stand, usually two or three days, and never more than a week. Weight-bearing with crutches was then not only permitted, but encouraged. The extent and effectiveness of the weight-bearing was manifested in the softening of the sole of the spica. Following removal of the spica at the end of about twelve weeks, crutches were used for five or six weeks until the patient's confidence returned. Rarely was any passive physical therapy employed. The

FIG. 1-A

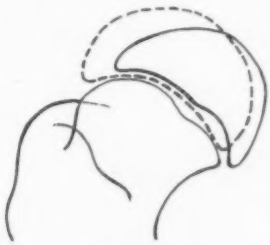

FIG. 1-B

Fig. 1-A: Case 2, aged twelve and a half years. Roentgenogram prior to treatment shows early slipping with marked broadening and irregularity of the epiphyseal plate.

Fig. 1-B: Indicates degree of slipping.

FIG. 1-C

Roentgenogram following removal of spica at three months shows epiphyseal plate narrowed and regular.

FIG. 1-D

Roentgenogram three years later shows epiphysis fused in excellent position. (Epiphysis on opposite side is still open.)

FIG. 2-A

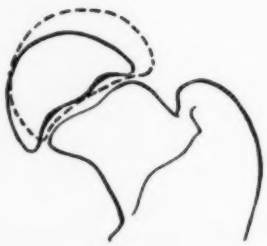

FIG. 2-B

Fig. 2-A: Case 3, aged fourteen and a half years. Roentgenogram prior to treatment shows early slipping with broadening and irregularity of epiphyseal plate.

Fig. 2-B: Indicates degree of slipping.

FIG. 2-C

FIG. 2-D

Roentgenograms two years later show epiphysis fused in excellent position. (Opposite epiphysis is open.)

Fig. 2-C: Anteroposterior view. Fig. 2-D: Lateral view.

functional and clinical results were excellent, and the roentgenographic studies after an average period of more than two years showed the capital epiphyses fused in very satisfactory position (Figs. 1-D, 2-C, 2-D, 3-C, and 3-D). It is not claimed that manipulation in this group affects the relationship of the head and neck, but rather that under anaesthesia, muscle spasm subsides, and a more satisfactory position of the extremity for weight-bearing is retained until fusion of the epiphysis occurs.

Two patients gave a history of early slipping to which apparently little if any attention was paid. There then intervened a sudden trauma resulting in acute slipping of the epiphysis with marked displacement (Fig. 3-A). It would seem that nature has here graciously, though somewhat perversely from the patient's point of view, done what we would have liked to do, but

have been unable to do effectively. The head and neck have been separated completely, and an opportunity is afforded to restore the relationship very accurately. Judging by the results of epiphyseal fractures in general, early and complete fusion can be anticipated in these cases as a result of the additional traumatization. There is one catch, however,—the reduction must be effected within a few days after the acute slip, or manipulation will be futile. Deformity and open operation are the penalty for the delay. In these cases the dislocation was satisfactorily reduced early by manipulation, and fixed by the method described. The functional end results were excellent, and roentgenograms revealed the epiphysis fused in satisfactory position (Figs. 3-C and 3-D).

FIG. 3-A

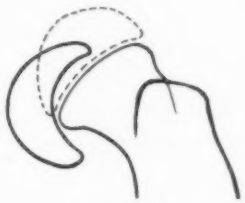

FIG. 3-B

Fig. 3-A: Case 7, aged twelve years, had gradual slipping with history of severe intervening trauma. Roentgenogram following acute injury shows complete disruption of head and neck.
Fig. 3-B: Shows degree of slipping.

FIG. 3-C

FIG. 3-D

Roentgenograms one and a half years after reduction show fused epiphysis in excellent position. (Opposite epiphysis is open.)
Fig. 3-C: Anterior view. Fig. 3-D: Lateral view.

TABLE I

RÉSUMÉ OF EIGHT CASES OF SLIPPING FEMORAL EPIPHYSIS

	Sex	Age	Body Type	Side	Onset	Duration of Symptoms	Symptoms	Physical Findings
Case 1	M	14	Fröhlich	L	Spontaneous	3 weeks	Limp on the affected side. Slight to moderate pain in hip, occasionally referred to thigh and knee.	Limitation of abduction, internal rotation, and flexion, slight to moderate in degree.
Case 2	M	12½	Fröhlich	L		2 weeks		
Case 3	M	14½	Fröhlich	R		5 weeks		
Case 4	F	11	obese	R		4 weeks		
Case 5	M	11½	Fröhlich	R		4 weeks		
Case 6	M	14	obese	L		6 weeks		
Case 7*	M	12	obese	L	Fall on hip following previous history of pain and limp.	8 weeks before fall	Marked pain in hip with complete disability following the acute injury.	Like fracture. Hip maintained in external rotation. Marked local tenderness, and great pain on motion.
Case 8*	F	14	normal	R		5 months before fall		

* Cases with severe intercurrent trauma.

COMMENT

It is the author's feeling that early weight-bearing in a group of patients already handicapped by obesity is a desirable consideration. Besides, the effect on the epiphysis seems to encourage early fusion in a manner less direct, to be sure, than that advised by Jahss [4], Bozsan [1], Telson, Mayer [6], Ferguson and Howorth [2], and Wilson [8], but in my experience, none the less effective. All of these cases showed roentgenographic evidence of epiphyseal fusion within the period of treatment. In none of the cases did slipping increase during the course of the patient's activity in the spica, and it is the author's opinion that it will not occur if marked internal rotation and abduction are maintained. Another consideration, perhaps less significant but still worthy of thought, is the fact

TABLE I (*Continued*)

RÉSUMÉ OF EIGHT CASES OF SLIPPING FEMORAL EPIPHYSIS

Roentgenographic Findings	Treatment	Duration of Treatment	Follow-Up Period (*Years*)	End Result	Final Roentgenograms	Rating
Signs of early slipping: broadening of epiphyseal line, and loss of overhanging superior lip of the epiphyseal cap (Figs. 1-A, 2-A).	Manipulation under anaesthesia into abduction, internal rotation, and slight flexion; application of a walking spica, and weight-bearing in 1 to 2 days.	Walking spica for 8 to 12 weeks, followed by the use of crutches for a variable period.	4½	No symptoms. Examination negative except for slight restriction of flexion.	No case showed progress of deformity. The capital epiphysis was completely fused in all but one case. The capital epiphysis of the opposite hip was fused in none.	Excellent
			3	No symptoms. Examination negative (Fig. 1-D).		Excellent
			2	No symptoms. Examination negative (Figs. 2-C and 2-D).		Excellent
			1¼	Slight discomfort on fatigue. Slight limitation of abduction.		Good plus
			¾	No symptoms. Examination negative.		Excellent
			⅚	No symptoms. Examination negative except for slight limp.		Excellent
Complete epiphyseal slip, resulting from acute dissolution at the epiphyseal site (Fig. 3-A).	Reduction by Leadbetter manoeuver; application of walking spica cast; and weight-bearing in 1 to 2 days.	Spica for 12 weeks. Crutches.	1½	No symptoms. Examination negative (Figs. 3-C and 3-D).		Excellent
		Spica for 16 weeks. Crutches.	1⅓	No symptoms. Examination negative.		Excellent

that confinement and inactivity are particularly resented by adolescents. The security of the plaster gave this group a wide latitude in their activity, and their agility in the spica was in some cases little short of amazing. They remained cheerful and happy throughout the course of the treatment, and were, as a result, a much lighter burden on their parents. From the point of view of economy, the shorter period of hospitalization and the small amount of after-care also recommend this treatment.

SUMMARY AND CONCLUSIONS

We have presented a group of consecutive unselected cases, presenting the characteristics of slipping of the upper femoral epiphysis, in various stages, and in different types of individuals. It is evident that

in early cases the treatment described effects early fusion of the epiphysis with excellent preservation of function. Cases of gradual slipping in which an acute injury supervenes give especially satisfactory results if promptly treated. Unless special indications arise, conservative treatment by manipulation into forced abduction and internal rotation, followed by the use of an ambulatory spica, is a satisfactory method of treatment, and should not be entirely discarded for more radical methods.

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INTRUSION OF THE SMITH-PETERSEN NAIL INTO THE ACETABULUM

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The possibility of intrusion of the Smith-Petersen nail into the acetabulum was first called to the author's attention by Dr. W. W. Plummer of Buffalo, New York, over a year ago. At that time he recounted his experience with a case, and discussed its probable mechanism. Since then the author has had a similar experience and this, together with the case which Dr. Plummer has kindly given us for publication, forms the basis of this report.

Before the nail became established as the method of choice for the treatment of fresh fractures of the femoral neck, critics pointed out that it frequently became loose and tended to extrude. In answer to this Smith-Petersen brought out the fact that in cases of absorption of the femoral neck it is necessary for the nail to be extruded unless the fragments are to be separated. According to most authorities, in the healing of fractures there is usually absorption of the contiguous ends of the fragments. This may be minimal in amount and not of clinical importance. However, careful comparison of roentgenograms in our fresh fractures of the femoral neck which have gone on to union, shows a measurable shortening, by the time union has occurred, in over two-thirds of the cases. The average change in these cases with shortening is about three-eighths of an inch (.95 cm.) although shortening of as much as three-fourths of an inch (1.9 cm.) occurred in some. It is a well known fact that even complete absorption of the femoral neck may occur in cases of non-union.

In these cases of absorption of the femoral neck, as well as in several other cases, the nail has usually been extruded. However, in the two cases being reported, the nail was so firmly fixed in the cortex of the femoral shaft that, as the neck shortened, the nail penetrated the acetabulum. In the first of these it is difficult to explain the reason for the fixation of the nail. In the second, fixation appears to be due to the overgrowth of callus over the head of the nail.

CASE 1. C. M., spinster, aged seventy-four, fell over a curb on October 20, 1938, and injured her right hip. She was treated at home in traction for three weeks before roentgenograms were taken. These showed a fracture of the femoral neck, and she was referred to us slightly over one month after her fracture.

The family history was not important, except that her father had died of paresis. She appeared a senile white woman. There was a loud systolic heart murmur with a collapsing pulse. The right lower extremity was in complete external rotation with an inch of shortening. Roentgenograms showed a transcervical fracture, somewhat oblique, with a protruding spicule of bone on the inferior margin of the proximal fragment. There was sclerosis about the margins of the fracture. An orthodiagram showed widening and

tortuosity of the ascending aorta with calcification of the aortic arch. The blood Kahn test was positive.

She was treated with Russell traction while her preoperative studies were carried out. It was the opinion of our medical department that she had cardiovascular syphilis with aortic insufficiency, but that surgery was not contra-indicated. Antisyphilitic treatment was begun. Because of the time elapsed since the fracture and the presence of the oblique spicule on the proximal fragment, the case was not considered suitable for closed nailing. Accordingly, on November 30, 1938, open reduction was done. Reduction was accomplished without difficulty, though it was noticed that the fragments of the femoral neck were hollow, and that the nail encountered no resistance in the neck. A satisfactory nailing was obtained (Fig. 1).

The postoperative course was uneventful, and on January 19, 1939, the woman was sent home to remain in bed without fixation. On discharge she had a good range of passive motion in the hip. She returned March 23, 1939, at which time she was asymptomatic and roentgenograms showed no change in position. There was no definite bony union. She was still not allowed weight-bearing. She again returned on July 6, 1939, complaining of a pain in the hip which was referred down the medial side of the thigh on motion. There was limitation of rotation and abduction of the thigh. Roentgenograms at that time showed what appeared to be a slight encroachment of the nail upon the cartilage of the femoral head. Bony union still had not taken place, and so, under local anaesthesia, the nail was withdrawn about one-quarter of an inch. Following this she had good painless motion, and was sent home without bearing weight. She returned again October 26, 1939, complaining of pain on motion of the hip. She had had pain for several weeks, but had not found a way to return sooner. Examination showed limitation of motion in all directions with pain when motion was attempted. There was tenderness over the head of the nail. Roentgenograms showed shortening, and absorption of the femoral neck with the nail protruding into the acetabulum. There was no bony union (Fig. 2).

Under local anaesthesia the nail was removed. The nail, usually found to be loose

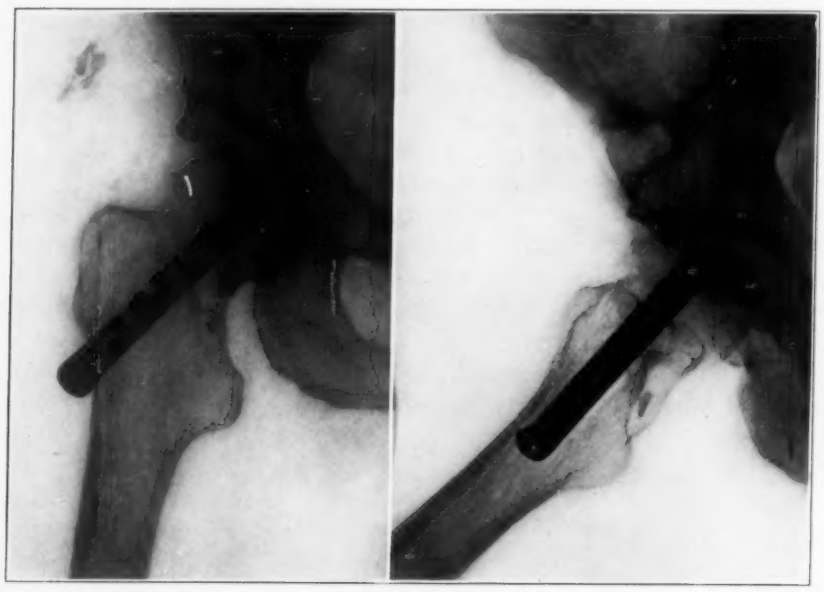

FIG. 1

Case 1. Postoperative roentgenograms showing the reduction which was considered satisfactory, though it would have been improved by a more valgus position of the nail.

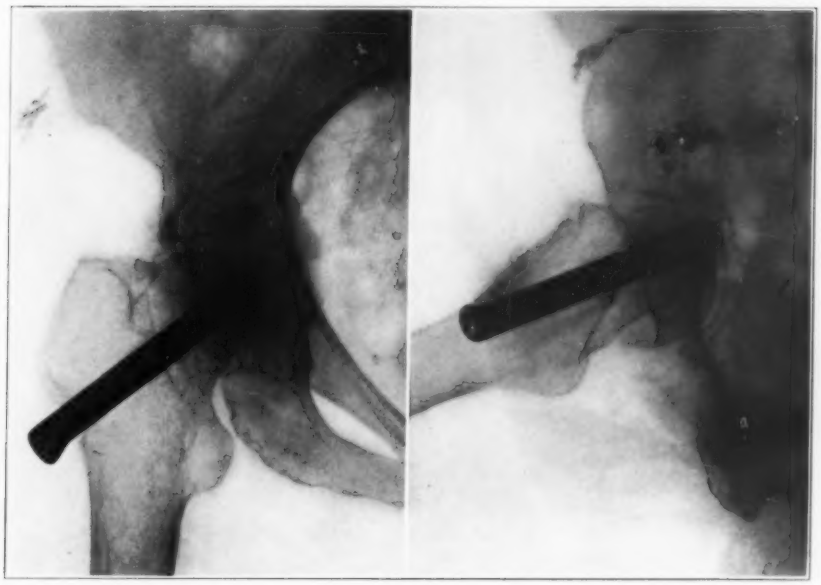

FIG. 2

Case 1. Roentgenograms show the joint just before the nail was removed. The nail had previously been extracted slightly from its original position. Note marked shortening of the femoral neck with the intrusion of the nail into the acetabulum.

after this length of time, was firmly fixed in the cortex of the femoral shaft, and was removed only after a strong pull with the nail extractor. After the nail was removed the fragments did not lose position, motion was more free and only mildly painful. She was discharged not able to bear weight. She was last seen February 19, 1940. Roentgenograms showed non-union with a dead femoral head. She refused further surgery and was given a walking caliper.

CASE 2.* Mrs. H. G., aged seventy, received an intracapsular fracture of the neck of the left femur in December, 1937. Immediate reduction was carried out, and closed nailing with a three-flanged Smith-Petersen nail was done. Roentgenograms taken after the nailing showed that satisfactory reduction and fixation had been obtained (Fig. 3).

Her convalescence was uneventful, and, at the end of four months, she was allowed up with crutches, but without weight-bearing on the affected extremity. A flat roentgenogram of the hip taken in April, 1938, showed the relationship of the fragments unchanged from the original x-rays. Another roentgenogram, taken July 18, 1938, still showed satisfactory position. However, on comparing this with the original x-rays taken at the time of nailing, there was evidence that the point of the nail was slightly closer to the capital cartilage than it was after the operation. At that time she had no discomfort in the hip, and the range of motion was satisfactory. She was permitted crutches, but not weight-bearing and was not very active.

About the middle of August, 1938, she began to have pain in the hip on motion. At first she did not give great attention to the pain as she had had hypertrophic spondylitis with involvement of various other joints, and was accustomed to some discomfort. The pain became worse, and about four weeks after its onset she was seen again for examination. At that time she showed definite evidence of intra-articular pathology. Motion of the hip was limited and painful. Roentgenograms made at that time showed

* Dr. Plummer's case.

FIG. 3

Case 2. Postoperative roentgenograms showing satisfactory reduction, and position of the nail. The nail head appears slightly embedded in the femoral cortex.

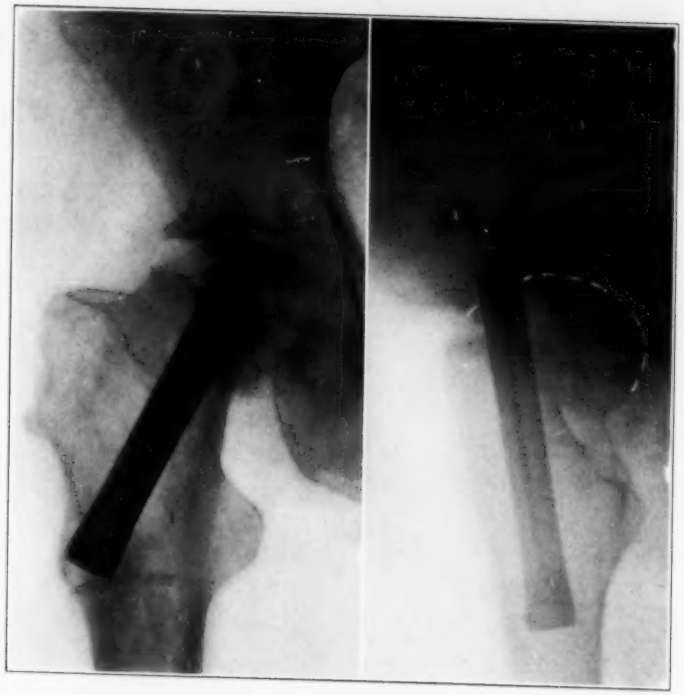

FIG. 4

Case 2. Roentgenograms show position of the nail before removal. Note callus over the head of the nail; varus and posterior displacement of the proximal fragment; and invasion of the acetabulum by the point of the nail.

definite protrusion of the nail through the head of the femur and into the acetabulum. The head of the femur was shown to be rotated posteriorly. There was an overgrowth of callus over the head of the nail (Fig. 4).

In October, 1938, the nail was withdrawn. Following this there was some improvement so far as the hip pain was concerned, but she was unable to bear her weight upon the leg. It was believed that the fragments had again become displaced, and that the head was undergoing aseptic absorption. No roentgenograms could be obtained to verify this conclusion. She died suddenly of a cerebral hemorrhage in February, 1940.

DISCUSSION

These cases are presented because it is believed that they represent a complication in the use of the three-flanged nail worthy of the attention of the surgeon. Felsenreich has already published a very detailed description of the histological pathology to be found in the hip joint following perforation of the femoral head by the nail. He has recognized shortening of the femoral neck as a cause of perforation, and faulty nailing as another; and has pointed out that if the nail only perforates minutely there may be a localized arthritis of no general significance. However, if it perforates grossly, as in these two cases, he has shown that there is a mechanical scouring of the hip socket by the nail point, which destroys the cartilage, and gives rise to loose pieces of cartilage in the joint. Felsenreich also stressed the fact that there may be solution of the nail by the synovial fluid, called a rust reaction, "*Rostgranulom*," which would cause chemical destruction of the joint cartilage. He found that this may extend through the cartilage over the head of the femur, and include destruction of the cortex of the head itself. He advised removal of the nail if healing had occurred or replacement by a shorter nail if it had not healed.

CONCLUSIONS

Two cases have been presented in which the nail was so firmly fixed in the cortex of the femoral shaft that, as the neck shortened, the nail penetrated the acetabulum. In the usual case, with similar femoral-neck shortening, the nail has been extruded. In the first of these two cases it is difficult to explain why the nail was so firmly fixed. In the second case fixation was probably due to an overgrowth of callus over the nail head. These two cases, and the observation that there is measurable shortening of the femoral neck in a large number of patients, point to the danger of mechanical fixation of the nail head to the femoral shaft. Such fixation has been advocated by several surgeons using various methods. Even when mechanical fixation has not been done, as in these two cases, the possibility of perforation of the femoral head should be considered whenever a previously satisfactory nailing becomes painful on motion.

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THE TREATMENT OF THE CEREBRAL PALSIES *

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There is such diversity of approach to the subject of the cerebral palsies that it is necessary to limit the present discussion to those data that have a relationship to treatment. In the past, little or nothing was done for this group of conditions. Spastic paralysis has been mentioned in the literature for more than 100 years, but athetosis and the ataxias of childhood have been mentioned only relatively recently. In 1826 Denis, Billard, and Cruveilhier suggested a causal relationship between intracranial hemorrhage at birth and spastic paralysis. Little presented his well-known monograph in 1862. He believed that 75 per cent. of all cases of spastic paralysis were due to cerebral hemorrhage at birth.

In 1910, Beneke described a new method of autopsy which would demonstrate tears of the tentorium and, hence, basal damage to the brain. It was this, more than anything else, which developed interest in the types of cerebral palsy other than true spastic paralysis. The possibility that these other types could also be due to injury at birth brought about great criticism of obstetricians which reached its height about 1920.

Since that time, the studies of etiology have shown that many factors, which are entirely beyond the control of the obstetricians, enter into birth injury, and that really poor obstetrics will account for only a very small number of the cases. However, cerebral palsy seems mainly a human condition, since its occurrence in any of the animals, even the anthropoids, is exceedingly rare. For a discussion of the various etiological factors, reference is made to the papers of Heyman, Schreiber, Pusitz, Langenskiöld, and others.

With regard to the treatment of the cerebral palsies, there has been until very recently, little or nothing in the literature. Certain procedures, such as nerve anastomosis, were described by Spiller and Frazier as early as 1905, and again by Allison and Schwab in 1910. Förster described posterior root resection in 1908, and Stoffel described neurectomy in 1911. The use of non-surgical, essentially physiotherapeutic, measures dates from the last decade of the nineteenth century, but no definite principles have been laid down.

More recently special procedures such as Chandler's operation on the tibial tubercle, Durham's operation for correction of internal rotation, Brewster's work with foot stabilization, Tubby's transplantation of the pronator teres, the various operative procedures for shoulder and elbow conditions, and many others have been developed. The results of

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons at Boston, Massachusetts, January 24, 1940.

TABLE I

MENTAL STATUS OF 301 UNSELECTED PATIENTS WITH CEREBRAL PALSY

Classification	No.	Per Cent.	
Superior	15	5.0	68.8
High average	29	9.7	
Average	88	29.2	
Low average	35	11.6	
Dull normal	40	13.3	
Borderline	16	5.3	
Feebleminded	78	25.9	
Total	301	100.0	

these operations have varied widely. None of them seems entirely satisfactory, and yet all of them have enough value to be retained in the surgical armamentarium.

In undertaking a thorough study of the problem, it seemed advisable to assemble all the data that could be obtained with regard to the condition. Surveys in various parts of the country were begun three or four years ago, and as yet are far from complete. However, the number of cases surveyed is now large enough to show that the percentages obtained are not materially changing.

A survey of children two to sixteen years of age in the state of Maryland showed a yearly occurrence of seven cerebral palsy births per 100,000 population. This figure checks almost exactly in both rural and urban areas. In other parts of the country which have been surveyed, this ratio is also fairly constant. It is interesting that in Maryland, with a comparatively high Negro population, the percentage of cases found in the Negro race is much lower than in the white race.

TABLE II

DISTRIBUTION IN SCHOOL OF 199 PATIENTS WITH CEREBRAL PALSY

School Status	No.	Per Cent.	
2 grades advanced	1	0.5	68.9
1 " "	4	2.0	
At grade for age	32	16.1	
1 grade retarded	41	20.6	
2 " "	29	14.6	
3 " "	30	15.1	
4 " "	13	6.5	
5 " "	11	5.5	
6 " "	16	8.0	
Special class	22	11.1	
Total	199	100.0	

TABLE III

DEGREE OF HANDICAP OF 271 PATIENTS WITH CEREBRAL PALSY

Degree of Handicap	No.	Per Cent.	
Mild	75	27.7	72.0
Moderate	120	44.3	
Severe	76	28.0	
Total	271	100.0	

This figure then, in a city of 100,000 would represent seventy patients under ten years of age, or 140 under twenty years of age. It would be lowered by those dying during childhood, but increased by those over twenty-one, since most of these surveys did not include any cases over twenty-one. By means of this figure, the general assumption can be made that there must be in the United States at least 150,000 cases of cerebral palsy.

A study was made in New Jersey to determine what percentage of cases had sufficiently high mental status to become worth-while members of society, if the physical difficulties could be alleviated. A chronological series was studied for mental status by McIntire with the findings shown in Table I. It may be seen that those grouped in the first five classifications constitute 68.8 per cent. of the total.

These results were checked, where possible, with school records. It is interesting that of those checked, those who were not more than three grades retarded again constituted practically the same per cent., 68.9. These figures are entirely independent of the degree of handicap, but are for the same groups which were studied orthopaedically.

The degree of handicap in 271 cases was judged arbitrarily and is shown in Table III. The degree of handicap is not an indication regarding treatment.

Table IV gives the extent of the handicap, or part of the body involved.

The totals in the tables, which are based on the New Jersey survey,

TABLE IV

EXTENT OF HANDICAP OF 306 PATIENTS WITH CEREBRAL PALSY

Extent of Handicap	No.	Per Cent.
Quadriplegia	175	57.2
Triplegia	23	7.5
Hemiplegia	67	21.9
Paraplegia	36	11.8
Monoplegia	5	1.6
Total	306	100.0

vary because all data were not obtained on each case. However, all cases are included in which the data were recorded.

Bearing in mind that 68.8 per cent. of cases show good mental ability, and that 72 per cent. are of mild or moderate degree of severity, it would seem that the problem of the cerebral palsies includes a large number of patients who would justify the time and expense of treatment. It should be remembered, however, that severity of involvement is not always a contra-indication to treatment. It may be highly desirable, for example, to rehabilitate the hands for self-care and ability to use a wheel chair in a quadriplegic whose legs are hopeless.

There is no one class or economic status in which the condition is more prevalent than in any other, and the distribution is fairly even. Hence, the number of patients able to pay for their own treatment is in direct proportion to the economic status of the population at large.

The condition differs particularly from poliomyelitis in that there are no epidemics, and no unforeseen developments. There is at present little hope of checking the condition, and the problem of care and treatment can, therefore, be prepared for in advance.

Treatment depends first, upon a careful diagnosis of the particular kind of cerebral palsy. For several reasons, the cerebral palsies have been divided into three general types — spastic, athetoid, and ataxic.

Spasticity is characterized by the stretch reflex. Hence, the way an attempt to move will be blocked is always predictable to the patient. Spasticity is a pyramidal-tract condition, often cortical, and, hence, the type in which true mental deficiency is most likely to occur. Spasticity is susceptible to muscle examination because of the fixed nature of the condition, and, therefore, susceptible to surgery.

Athetosis is characterized by involuntary motion, so that interference with an attempt to move is never predictable to the patient. Athetosis is a basilar or non-pyramidal-tract condition, and the type in which true mental defect is not likely to occur. Athetosis is not well-suited to muscle examination, since the motions are total joint "attempts" and will persist with what muscles are left even if some are cut, neurectomized, or transplanted. Consequently, athetosis is not improved by peripheral surgery (at least as we know it now), except for the correction of true contractures.

Spasticity resembles athetosis because the stretch reflex may start a whole train of involuntary motions, and because some of the reflexes may not appear to be hyperactive if the muscles being tested are not spastic muscles.

Athetosis resembles spasticity because of the voluntary, often habitual, tension set up to stop the involuntary motion, and because some of the reflexes may appear to be hyperactive, due to the automatic reinforcement by involuntary motion elsewhere in the body, or by tension.

Ataxia is a disturbance of balance and postural or directional sense, without interference with motion either by spasticity or involuntary mo-

TABLE V

DISTRIBUTION OF TYPES OF PARALYSIS IN 350 PATIENTS WITH CEREBRAL PALSY

Type of Paralysis	No.	Per Cent.
Spastic	189	54.0
Athetoid	143	40.9
Ataxic	18	5.1
Total	350	100.0

tion. It is, also, not susceptible to surgery, except for correction of true contractures.

Table V shows the distribution of these types of cases in a consecutive series in New Jersey.

The author's series of eighty-nine cases was observed for a period of two years at the Children's Rehabilitation Institute, a boarding-hospital-school for cerebral palsy patients. They ranged in age from three to thirty-two years, though almost all were under twenty-one. The proportions of spastic, athetoid, and ataxic cases were similar to those in the surveys, but the average mental status was considerably higher because the Children's Rehabilitation Institute does not accept definitely defective children.

GENERAL PRINCIPLES OF TREATMENT

Spasticity

A complete muscle examination should be made in all cases. For this purpose the usual muscle-examination forms used in poliomyelitis are entirely satisfactory. However, the muscles should be graded essentially according to those which show spasticity; those which are normal; those which are weak (but otherwise normal); and finally those which the patient is unable to contract. Spastic muscles are tested by means of eliciting the stretch reflex. An attempt is made to move the joint rapidly in the opposite direction to that of the contraction of the muscle under observation. As soon as the motion begins to take place, the stretching causes a contraction of the muscles, blocking free motion. Normal or weak muscles are tested in the usual way, but allowance must be made for the possible spasticity of their antagonists before making a final decision. Flaccid muscles are those which the patient is unable to move voluntarily even if their antagonists are normal. These can be made to contract in some instances by means of resisted contractions in other parts of the body. These confusion contractions are very useful in retraining cerebral-flaccid muscles.

No surgery should be performed on a spastic patient without a muscle examination, as the condition of the antagonists of the muscles under consideration is often the deciding factor in determining the procedure.

In conservative treatment, the flaccid muscles and weak muscles must be protected from the weakening effect of undue stretching, and the spastic muscles must be protected from the strengthening effect of the

stretch reflex. With treatment by selective massage, and careful exercise with appropriate splinting and protection, a great change in muscle balance may be attained. The amount of surgery apparently necessary at first will be greatly diminished.

Athetosis

In this condition a muscle examination will demonstrate those muscles which move involuntarily and those which do not. This picture remains relatively fixed, but it is the *motions* carried out by the athetosis rather than the muscles which really give the fixed picture. Patients have been seen in which previously athetoid muscles have been thrown out of function, either by neurectomy, tenotomy, or even transplantation, and the direction of the athetoid *motion* remains unchanged as long as there is any muscle power left to move it in that direction. Thus, athetosis seems better conceived as an involuntary attempt to move a joint in a certain way, than as an involuntary stimulation of any individual muscle. Surgery of the muscles, nerves, or tendons, has, therefore, very little effect. Joint stabilizations are exceedingly difficult in athetosis because it is almost impossible to maintain enough fixation for good fusion. The discomfort of the patient following the operation is very great, and there is much difficulty with pressure sores. In general, surgery is unsuccessful. In severe cases Putnam's procedure of lateral cord section is helpful, but it serves more to quiet the athetosis than to increase function. The use of curare, as described by Burman, is still definitely experimental, but its further development should be watched with interest.

Relaxation, taught by a carefully graded system, beginning with the least athetoid parts of the body and, when learned, extended to the more athetoid extremities, is, over a long period of time, very effective. This, combined with motion from the relaxed position, is the most effective form of treatment, and eventually brings about very satisfactory results.

Ataxia

The treatment of this condition is simply that of training the voluntary motor centers to take over the function of the damaged balance mechanism. It can be compared to the learning of any other skill, such as playing the piano. At first, all the attention must be fixed on the skill being learned, but later it can be carried out almost without thought. Thus, with sufficient practice, the skill of balance and directional control can be learned in a similar manner, and eventually becomes habitual.

Because of the fact that, in general, the various disturbances of the motor system constituting cerebral palsy start at birth, many essential fundamental motor patterns, such as reciprocation in the legs, and the reach and grasp in the arms, usually learned during early babyhood, are not automatically developed. Without these two, especially, neither

walking nor the proper use of the arms is possible. Besides this, many bad habits in use of the arms and legs are established, frequently very early. These become fixed, as does the assistance given the child by the family (their habits toward him), so that retraining is badly handicapped. The educational difficulties are also great, and frequently require special methods.

The ideal method of training these patients is, therefore, in a school or institution especially set up to meet their needs both physically and educationally, until such time as the bad habits can be broken up, and rehabilitation carried out to the point where the children can be entered in a day school.

There is great danger of old habits returning at home, because they are so closely bound up with the home environment. However, a period of institutional life long enough for the children to establish new habits of use of muscles and of care for themselves, associated with an intensive educational stimulus, is very effective in preparation for future placement in a day school.

It seems essential, however, that, after discharge from the institution, treatment be continued individually, at least three times a week, for a considerable length of time to insure fixation of progress. Treatment should be tapered off very gradually, over a period of years in most cases, as the skills which are taught take the place of the exercises.

Home treatment in some instances is, nevertheless, very effective. While it is not possible to train a mother or nurse to treat all cases, it is entirely possible, in a week or so, to train most intelligent mothers or nurses to treat one individual child. After demonstrating the work thoroughly to the mother, and watching her carry it out under direction, a very carefully worked out schema, with detailed directions for that particular child, should be given to her. This home treatment cannot be generalized, but must be especially worked out for each individual child. The mother or nurse then carries out the procedures daily with return of the patient to the physician at frequent intervals.

The obtainable results are in three fields,—use of the legs, use of the arms, and speech. The disorders of speech in cerebral palsy are an extensive source of investigation at present, but, in brief, they are exactly parallel with the difficulties in the arms and legs. They are spastic, athetoid, or ataxic, and the same principles of treatment apply. Satisfactory progress can be made only if the speech trainer thoroughly understands the type of underlying difficulty. In this field also habits of use are the greatest obstacles to overcome.

Results in the legs are measurable in the perfection of gait. In some instances it is possible to teach walking even as late as adolescence, if the right fundamentals are stressed. Two such cases were sixteen-year-old athetoid girls who had never walked previously. Their difficulty was that they had not learned the underlying principle of reciprocation. Another was a twelve-year-old ataxic. Others are taught to

walk with heel placement instead of toe placement, and other improvements—such as speed of walking and better appearance of gait—can be made.

In the use of the arms the results are harder to evaluate, but ability to dress and feed oneself is a good measure.

In speech the results are slower, but a few can be taught to speak, and the defective speech in others can be cleared up.

In the school proper, the teaching is aimed at bringing the children up to their grade level in all subjects, and this can be accomplished in the majority of cases with the use of special teaching methods.

A careful study of each child should be made with regard to rehabilitation for adult life. This is usually carried along two chief lines which point toward vocational and avocational interests, and the physical and mental abilities are trained toward these ends.

SUMMARY

1. Cerebral palsy, representing about seven births per 100,000 population per year, presents a real problem with regard to the number of cases.

2. Mental level is sufficiently high in about 70 per cent. of the total to make treatment worth while.

3. The incidence of the condition, unlike epidemic poliomyelitis, is at present entirely predictable, and plans can be made in advance for treatment of a definite number of cases.

4. The importance, with regard to treatment, of accurate diagnosis of spastic, athetoid, and ataxic palsy, must be emphasized, even though differential diagnosis is occasionally very difficult.

5. The present use of surgery is essentially limited to the true spastic, except for contractures.

6. The most effective method of treatment is the special school where physical reeducation and schooling can be carried out together.

7. There must be close cooperation and mutual understanding of the problem among the educators, the doctors, and the family of the patient.

8. Home retraining is, in some instances, very effective, and, in most cases, should at least be given a trial of several months before deciding on the special school.

9. Satisfactory results, judged by the standards of other crippling conditions, are obtained when care and treatment are sufficiently intensive.

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LEGG-PERTHES DISEASE OF THE HIP: ITS EARLY ROENTGENOGRAPHIC MANIFESTATIONS AND ITS CYCLICAL COURSE *

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The name Legg-Perthes disease of the hip is employed for want of a better one. Legg-Waldenström-Calvé-Perthes disease is too cumbersome a title. Coxa plana is incorrect because the head does not become flattened if, during the course of this disease, it is protected from weight-bearing and muscle spasm. There is no evidence in support of osteochondritis as the disease is not one of inflammation of bone and cartilage. The primary fault is not in the acetabulum; so this disease cannot be called pelvis plana. One must sharply differentiate the true Legg-Perthes disease from a somewhat similar condition which is often observed in the head of the femur in cases of congenital dislocation of the hip.

ETIOLOGY

The etiology of this disease has not been determined. The author has observed the onset of symptoms in children between the ages of three and eleven years. There is reason to believe that the hips have been normal before the onset of the disease because, at the very beginning of the changes that are visible in the roentgenogram, the affected hip is entirely similar to the opposite unaffected one in size, shape, and density, except for the evidence of local necrosis that will be mentioned later.

Between 85 and 90 per cent. of the patients are boys. This is the reverse of the sex incidence in congenital dislocation of the hip.

A history of definite injury immediately preceding the onset of symptoms has been obtained in a few cases. More frequently such history is lacking.

Some cases show definite evidence of endocrine imbalance. This is suggestive of an etiological factor, but it cannot be accepted as the sole or universal one unless it can be proved in all cases of Legg-Perthes disease.

SYMPTOMS

The first symptoms are pain, more commonly felt in the region of the knee than the hip, and a limp in the affected leg. These symptoms are not often continuous. They frequently disappear after rest in bed for a few days. On first examination there is always some limitation of normal motions of the hip, particularly that of rotation of the femur. This sign also disappears readily after rest. There may be slight wasting of the muscles of the thigh; and a slight firm thickening of the hip can almost always be felt by careful palpation. At the onset of symptoms the

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disease may be in an early stage or it may be far advanced. The author has seen cases within three weeks of the appearance of the first pain or limp, and the roentgenograms have shown marked necrosis of the head and the neck of the femur.

We have been able to study a number of cases, however, which presented the very early changes which are visible in this disease and, in several cases, even before the onset of symptoms. The striking and uniform feature is an early necrosis in the metaphysis of the neck of the femur. The areas of decalcification vary in number, size, shape, and location in the metaphysis. These irregular "holes" may first appear at the outer margin of the neck, or in the center, or, less commonly, at the inner margin. They may be small and irregularly rounded, or large and conical with the base of the cone upward against the epiphyseal plate. As time passes they multiply, enlarge, coalesce, and form a broad band across the entire metaphysis. Sometimes the band-like area of decalcification is seen in the first x-ray that is taken. It was discovered accidentally in the x-ray laboratory of the University of Pennsylvania that if the x-rays are slightly overexposed these areas of decalcification stand out more clearly.

DEGENERATION

The next feature found in our early cases is that concomitant or subsequent degenerative changes occur in the head of the femur, and that the first area of necrosis in the head directly overlies the first area of necrosis in the metaphysis. As the disease spreads in the metaphysis, it extends correspondingly in the head. It is difficult to escape the conclusion that the degeneration of the head is the result of the necrosis in the neck.

From these early beginnings the progress of the pathological process is well known: the appearance of irregular areas of decalcification in the head; the so-called fragmentation; isolated areas of increased density, which gradually become smaller until they may almost completely disappear; and the change in the size and shape of the head which becomes smaller and flatter until it may be barely visible. At times the head seems to have been almost entirely destroyed, as it appears only as a small, obscure body, not more than one-fourth inch in diameter, lying above the center of the metaphysis.

This phase of degeneration and disintegration extends through a period of about a year and a half. A study of more than twenty cases shows that there is some variation in the time consumed in this process. As mentioned above, the disease may be far advanced and of many months' duration before the onset of symptoms, and, therefore, before the first observations are made. In such cases it is difficult to compute the time occupied in the first part of the phase even though in each case the number of months that have been required to complete the degeneration have been determined. Furthermore, the lack of proper treatment,—that

is, continuous and prolonged rest—during this phase prolongs the time. From the writer's observation of the rate of degeneration in the cases followed continuously from the appearance of the early signs, it is possible to estimate approximately the duration of the disease in those cases which are first seen when the disease is well advanced. Combining all these factors it seems probable that the degenerative stage occupies, on the average, a period of about eighteen months; that it is prolonged beyond this period by lack of treatment; and shortened by adequate treatment that begins in the very early stage. Table I illustrates these statements.

REGENERATION

After the period of degeneration is completed that of regeneration begins. The turn in the cycle usually occurs abruptly. Our roentgenograms are taken at two-month intervals and the change from progressive destruction to a beginning reconstruction can be noted in two successive x-rays.

The regeneration is usually apparent in the metaphysis before it shows in the head. The decalcified areas in the neck begin to disappear as new bone forms. Then recalcification appears in the head. The areas of fragmentation begin to fade out; there is less density in the islands; and new bone appears in the portions of the head that were invisible. The head develops toward the margins and increases in thickness. The portions of the head and neck that showed the earliest evidence of necrosis are the first to show evidence of recovery. The metaphysis is restored to a normal appearance a long time before the regeneration of the head is completed.

The time required for complete regeneration is approximately between two and three years. This phase of the cycle is probably also delayed by absence of proper treatment. When it is finished the head and neck are restored almost to normal size and shape, and the acetabulum is normal if treatment by non-weight-bearing has been carried out consistently from the beginning. If there has been inadequate or no treatment, the well-known deformities of the head, neck, and socket are observed.

The fact that regeneration first appears in the metaphysis and is completed there first again points to the conclusion that the changes that occur in the head are dependent upon the primary changes in the metaphysis. If the necrotic neck is subjected to the crushing force of weight-bearing and of muscle spasm it becomes shortened and broadened. If it is protected from this force, it heals with but little or no deformity.

The eventual size and shape of the head are governed by the same principle. When the head regenerates, if it is well shaped, it sits on top of a well-shaped metaphysis; if it is deformed it rests upon a correspondingly deformed metaphysis. It regenerates through the regenerating epiphyseal plate and its underlying metaphysis.

We agree with Waldenström that the subluxation of the head and the accompanying thickening of the floor of the acetabulum are due to the flattening of the head when accompanied by weight-bearing and muscle pull. However, our cases show that if the softened head is protected from these forces it does not become flattened or subluxated, and the acetabulum does not become altered. We disagree with Waldenström in that we think the primary change is in the metaphysis and the epiphyseal plate, and not in the head.

Our present conception of Legg-Perthes disease is that it is due to a primary aseptic necrosis in the metaphysis. The necrosis is due to an interference with or blocking of the blood supply. The cases which show a large conical area of destruction point to thrombosis of a large vessel, and infarction. The cause of the circulatory damage is as yet unknown. The degenerative changes that occur in the head are also of the nature of aseptic necrosis, and are due to cutting off the blood supply through the metaphysis and the epiphyseal plate. The deformities that arise are due to the mechanical forces of weight-bearing and muscle tension. The fact that the necrosis in the neck is frequently slowly spreading and progressive would point to some constitutional cause rather than to a single traumatism.

DIAGNOSIS

The diagnosis is easily made when the pathological process is fairly well advanced, but it is attended with some difficulty in the very early stage. The appearance of necrosis in the metaphysis is so constant that the author is unwilling to make an x-ray diagnosis of Legg-Perthes disease without its presence. Careful comparison with the other femur, the use of magnifying and reducing lenses, and a moderate overexposure of the film will aid in its detection.

The author wishes to emphasize the value of careful palpation of the hips. If one sits on the side of the bed and places his fingers in the fossa behind the head and the neck and his thumb over the head in front, he thus grasps the hip between the thumb and the fingers. If he grasps the other hip in a similar manner with his other hand, he is able to feel a very slight difference in the thickness of the two hips, and to appreciate the nature of the thickening, whether it is soft or whether it is firm and resistant. A slight, but evident, firm thickening can almost always be felt in Legg-Perthes disease. Our records show that this diagnosis has often been made during the past ten years by palpation, and before x-ray examination has been made.

There is also an early thickening of the hip in tuberculosis. Indeed, the correct diagnosis can be made with the hands before it can be made by the x-ray appearance. But in tuberculosis the thickening is soft and more marked. This clearly distinguishes it from Legg-Perthes disease. Inasmuch as early x-ray diagnosis of these two conditions is frequently confused or undistinguished, the use of skillful palpation is of the greatest value.

CASE 1. B. G. (Figures 1-A through 1-I.)

FIG. 1-A

March 13, 1937. Very early necrosis of the inner and outer margins of the metaphysis. Very early decalcification of the outer margin of the head. Head is of normal size and shape; and acetabulum is normal.

FIG. 1–B

May 5, 1937. Necrosis of the inner and outer margins of the metaphysis is more evident, and is beginning to appear also in the entire metaphysis. Decalcification of the inner and particularly of the outer portion of head is more evident. Head is becoming thinner.

FIG. 1-C

September 22, 1937. Marked increase in the necrosis of the outer third of the metaphysis and extending downward almost to the greater trochanter. A well-defined narrow band extends across the entire metaphysis. Decalcification of outer third of head is marked, of the inner third moderate. There is increased density of the central portion of head, which is thinner.

CASE 1 (*Continued*)

FIG. 1-D

November 22, 1937. Necrosis of neck is not progressing. Destruction of the head is more marked, particularly in the outer third above the most marked area of necrosis in the metaphysis. Inner third of the head also shows advancing necrosis.

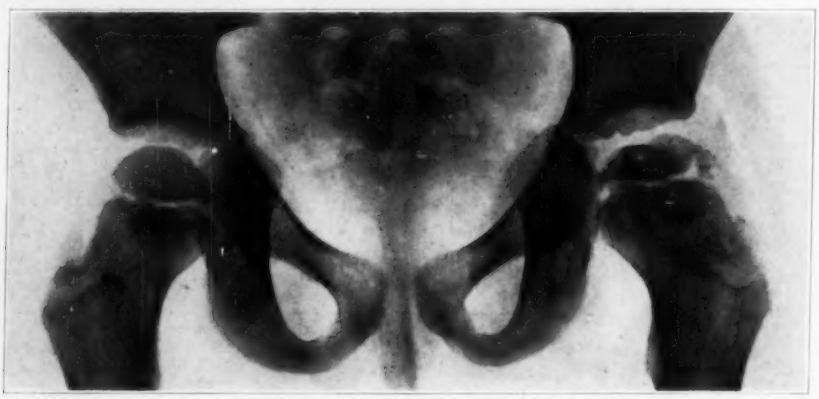

FIG. 1-E

March 7, 1938. The cycle has turned upward. Metaphysis is regenerating. Necrotic areas are barely visible. Recalcification of head is beginning and is most evident in the outer and inner thirds.

FIG. 1-F

September 13, 1938. Neck is practically healed. Head is of more uniform density. Hole in outer third is filling in. Central third, which was the last to show degeneration, is the last in regeneration.

CASE 1 (*Continued*)

FIG. 1-G

February 7, 1939. Head is larger and rounder. Central third lags behind other thirds.

FIG. 1-H

June 9, 1939. Neck is healed. Head is fairly well regenerated except for superior central portion.

FIG. 1-I

October 23, 1939. Neck is slightly broadened, not shortened. Head, regenerated except for the superior central portion, is slightly thinned, well-rounded, slightly broadened.

Routine tuberculin reactions have always been negative in Legg-Perthes disease, and the blood sedimentation rates have always been within normal limits.

SLIPPING EPIPHYSIS, EPIPHYSIOLYSIS

It is interesting to note that in this condition there is also an early, marked, bandlike necrosis of the metaphysis. It is often observed in boys who present a Fröhlich's syndrome, but it does not lead to the degenerative changes of the head that characterize Legg-Perthes disease, and healing takes place in a much shorter time. We do not know why this should be so. It suggests that the pathological process in Legg-Perthes disease is more serious and profound.

TREATMENT

In our earlier experience with the treatment of this condition we followed Legg's dictum that the disease ran a definite course which was not modified particularly by any form of treatment. But after Danforth's paper in 1934, we began to follow his method of prolonged rest in bed. Whenever possible the child is put to bed with Buck's extension on both legs, and is kept in bed until regeneration is well advanced. We then allow the child to go about with a walking brace with perineal crutch, high shoe on the well leg, and crutches. When we are able to carry out this method without interruption, the end results are practically perfect hips.

We are still uncertain when we may safely allow weight-bearing, but believe that regeneration should be well advanced when it is permitted.

Medical and dietary treatment with a full complement of vitamins should be carefully supervised.

Drilling: It is impossible to determine the results of such treatment unless one knows fairly accurately the phase of the cycle when the drilling is done. If the operation is performed near the end of the period of degeneration it might falsely be credited with the improvement which would follow naturally as the cycle begins its normal upward swing.

Endocrine Therapy: The same observations hold true for endocrine therapy as for drilling. The point to be determined is whether these methods shorten the time of one or both phases of the cycle as determined by treatment by prolonged non-weight-bearing. We have reason to believe that the cycle is lengthened when weight-bearing is permitted.

Shelf Operation: The author has used this method of operation when the disease has been neglected and is far advanced, with subluxation and deformity of the head and insufficiency of the socket. It has successfully added stability to the hip, and has apparently prevented increase in the deformity of the head.

CASE REPORTS

Case 1: B. G., male, aged five years, was presented for examination March 13, 1937. The history included a fall in October, 1936, in which patient struck left hip against the curb on the street. He was apparently well the following day, but developed a limp in

CASE 2. W. C. (Figures 2-A through 2-I.)

FIG. 2-A

April 28, 1937. Necrosis is well advanced in the central and outer portions of the metaphysis and in the corresponding part of head. Head is smaller and flattened; acetabulum is normal.

FIG. 2-B

September 3, 1937. There is necrosis of the entire metaphysis; entire head is degenerating.

FIG. 2-C

November 5, 1937. Necrosis of the head is more advanced and is most marked in the central and outer part where it began.

CASE 2 (*Continued*)

Fig. 2-D

February 22, 1938. Fragmentation of the head is more marked. Metaphysis shows beginning healing; decalcification is less marked.

FIG. 2-E

April 26, 1938. Healing of the central and outer part of head is beginning; density is more uniform. The cycle has definitely turned.

FIG. 2-F

September 8, 1938. Healing is well advanced. Head is flat, broad, and extends slightly beyond the acetabulum.

CASE 2 (*Continued*)

FIG. 2-G

December 13, 1938. Regeneration is progressing.

FIG. 2-H

March 23, 1939. Head is less mottled, more round, with the articular margin smooth.

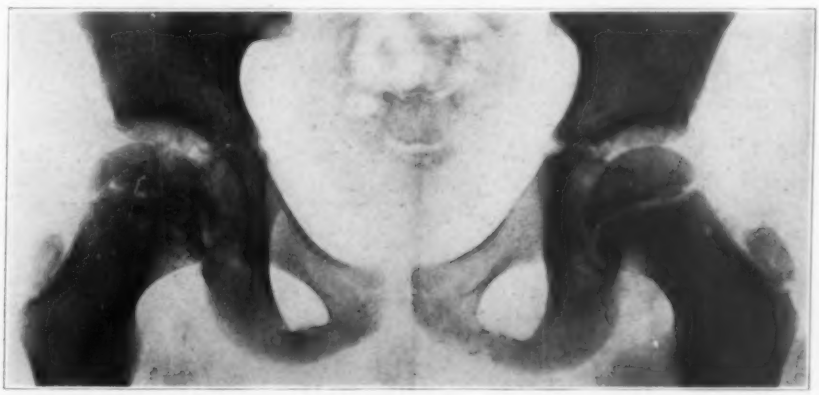

FIG. 2-I

August 10, 1939. Regeneration is far advanced. Upper end of the neck is but one-sixteenth of an inch wider than the neck of the left femur. There is no shortening. Head is one-sixteenth of an inch thinner than the left, well rounded, and protrudes slightly beyond the acetabulum. Regeneration is not yet completed.

CASE 3. R. E. (Figures 3-A through 3-G.)

FIG. 3-A

December 15, 1936. Necrosis of the outer third of the metaphysis and the head is marked. Head is small, dense in center, and fragmented in the outer third.

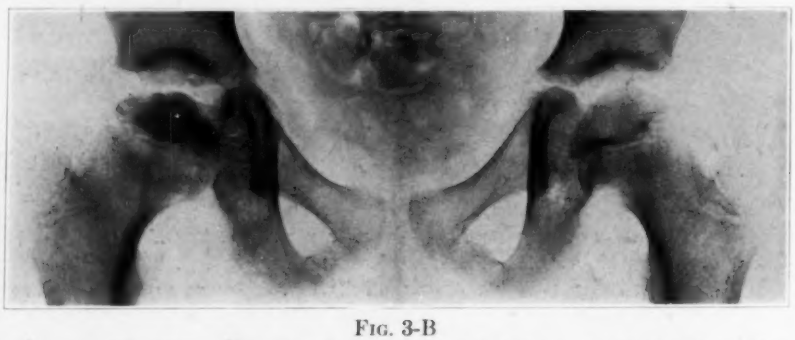

FIG. 3-B

January 27, 1937. Necrosis of the inner third of the metaphysis is becoming more evident.

FIG. 3-C

June 7, 1937. Necrosis has extended entirely across the metaphysis. Entire head is fragmenting.

FIG. 3-D

September 3, 1937. Regeneration of the outer third of the metaphysis is apparent, but is not so marked in the inner third. Head is showing regeneration in the outer third.

CASE 3 (*Continued*)

FIG. 3-E

August 25, 1938. Metaphysis is healed. Healing of the head is well advanced. There is a hole in the outer third, and incomplete recalcification in the superior central portion.

FIG. 3-F

July 29, 1939. Hole in the outer third of the head is filled; the superior central part appears to be detached and displaced upward.

FIG. 3-G

March 2, 1940. Head is entirely healed except for superior central part, where the detached fragment seems to be united and not projecting upward. Head is round, not deformed, and does not project beyond the acetabulum. Neck is normal. The distance from the base of the greater trochanter to the top of the head is but one-eighth inch less than in the opposite hip.

the left leg two weeks later. This was relieved by rest, but returned on activity. He had pain in the left knee which became worse. The course of the disease is demonstrated in Figures 1-A to 1-I.

The first x-ray (Fig. 1-A) was taken four and one-half months after the onset of symptoms, but the pathological changes are only slightly evident. This presents a strong contrast to other cases in which marked necrosis of the neck and the head is evident as early as three weeks after the onset of symptoms. The degenerative phase of the cycle lasted for about one year. Note that the neck and metaphysis show the earliest evidence of healing, and that their regeneration is completed long before the regeneration of the head is completed or even well advanced. The phase of regeneration (Figs. 1-E to 1-I) had continued for nineteen months but was incomplete at this time. In the earlier x-rays (Figs. 1-A to 1-E) the head appears to stand away from the bottom of the socket (Waldenström's sign), but in the later x-rays (Figs. 1-F to 1-I) it has returned to approximately its normal position (Fig. 1-H). There is no appreciable deformity of the socket. The final x-ray shows but one-sixteenth of an inch shortening of the head and neck as measured from the top of the head to the inferior portion of the greater trochanter or to any other given point.

Case 2: W. C., male, aged six and one fourth years, was admitted to University Hospital May 4, 1937. He had had a limp for six weeks, with pain in the right knee for ten days after the limp was noticed. Both limp and pain disappeared with rest. He was treated by rest in bed with extension for thirteen months; then by brace with pelvic band and perineal crutch, high shoe, and crutches for another period of ten months. Tuberculin reaction was negative, and blood sedimentation rate normal. The course of the disease is shown in Figures 2-A to 2-I.

This case shows well-marked necrosis six weeks after the onset of symptoms, and the degeneration continued for twelve months after admission. Regeneration has progressed for sixteen months and is not complete. Note that Waldenström's sign (the size of the elliptical area outlined by the posterior margin of the acetabulum and the inner portion of the head and neck) is never so marked as in Case 1. Note also the increased size of the space between the head and the roof of the socket in the earlier x-rays (Figs. 2-A to 2-C). This is possibly due to the decalcification of the upper portion of the head, which makes it invisible. In the succeeding x-rays (Figs. 2-D to 2-I) this space becomes filled up by the regenerating head.

Case 3: R. E., female, aged seven years, was admitted to University Hospital November 2, 1936. She had had a limp for over one month which had been noticed by her school teacher. There was no pain. The tuberculin reaction was negative. She was treated by bed rest and traction for twelve months, and by brace, crutches, and high shoe for another ten months. This case is illustrated by Figures 3-A to 3-G.

This case showed marked advancement of disease when seen one month after the onset of symptoms. Degeneration continued for ten months more. Regeneration has been in progress for thirty months and is not altogether completed. Note that Waldenström's sign is very positive in

CASE 4. G. M. (Figures 4-A through 4-J.)

FIG. 4-A

September 10, 1937. Decalcification, extending irregularly across neck, is more marked in the inner two-thirds. Head shows marked degeneration, fragmentation, and is small and thin.

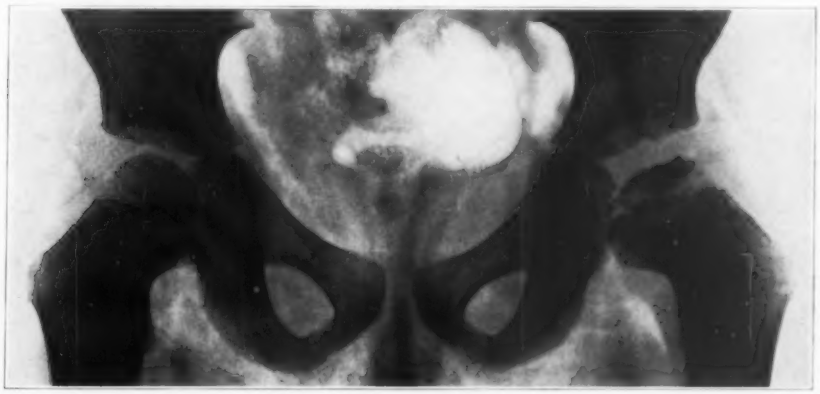

FIG. 4-B

November 20, 1937. There is an increase in the central necrosis of the metaphysis.

FIG. 4-C

April 1, 1938. Shows improvement in the metaphysis. Head has become very small and irregular.

FIG. 4-D

June 8, 1938. Continued definite recalcification of the metaphysis. Head has almost disappeared.

FIG. 4-E

August 23, 1938. Head is scarcely visible. Faint new calcification is appearing.

FIG. 4-F

November 4, 1938. Cycle has turned strongly upward.

FIG. 4-G

March 21, 1939. Regeneration is continuing.

CASE 4 (*Continued*)

FIG. 4-H

June 24, 1939.

FIG. 4-I

October 6, 1939. Head is rebuilding and becoming rounded. Metaphysis shows incomplete recalcification in the inner two-thirds.

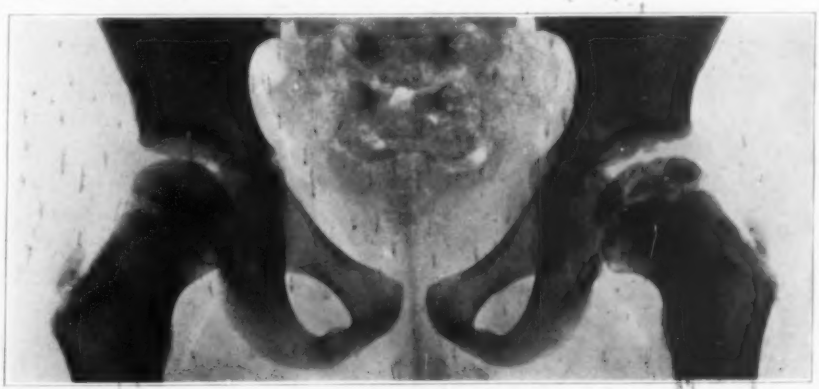

FIG. 4-J

April 4, 1940. Regeneration is incomplete. Head is thin, well rounded, and does not project beyond acetabulum. Regeneration is incomplete in the inner half of the neck.

CASE 5. D. B. (Figures 5-A through 5-E.)

FIG. 5-A

November 8, 1938. Six months after onset of symptoms. Head is very small, rounded, and faintly visible. The metaphysis shows a large, rounded, central, cupped area of necrosis.

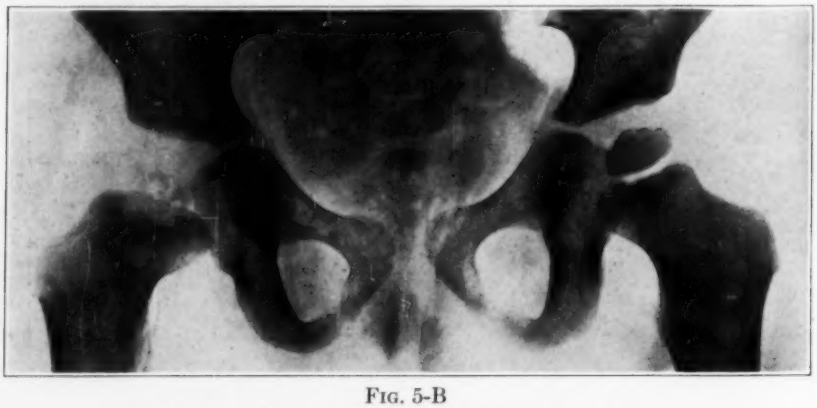

FIG. 5-B

March 8, 1939. Head is regenerating and enlarging.

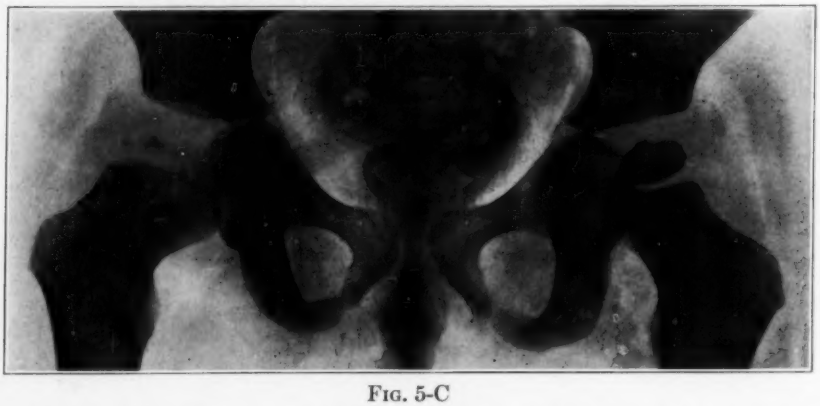

FIG. 5-C

April 8, 1939. There is marked development of the head within a month, and regeneration in the metaphysis.

CASE 5 (*Continued*)

FIG. 5-D

August 25, 1939. Continued rapid regeneration.

FIG. 5-E

February 12, 1940. Regeneration of head is incomplete. Metaphysis is almost healed. It is interesting to observe how well the head has reformed.

the earlier x-rays, but much less marked in the later ones. The final film does not show any thickening of the base of the socket or other deformity. As in all the other cases, the regeneration of the metaphysis is completed long before that of the head.

Case 4: G. M., male, aged three and one-half years, was admitted to University Hospital September 6, 1937. He had had pain and limp for six weeks. He was treated by bed rest and extension for nine months, with cast for four months, and then by high shoe and crutches. The course of the disease is shown in Figures 4-A to 4-J.

This case presents very marked degeneration six weeks after onset of symptoms. Degeneration continued for about twelve months. Regeneration, which has been in progress for seventeen months, is far from complete. Note that the metaphysis shows definite signs of recalcification while the decalcification of the head is continuing.

The following cases show unusual types of necrosis of the metaphysis.

CASE 6. W. O'B. (Figures 6-A through 6-G.)

FIG. 6-A

July 8, 1936. Shows marked necrosis of the inner and outer portions of the metaphysis with a central pillar of bone. Necrosis in head corresponds to that in the metaphysis.

FIG. 6-B

August 10, 1936. Shows lateral holes in the metaphysis.

FIG. 6-C

November 13, 1936. Recalcification is beginning in the metaphysis, but head is degenerating.

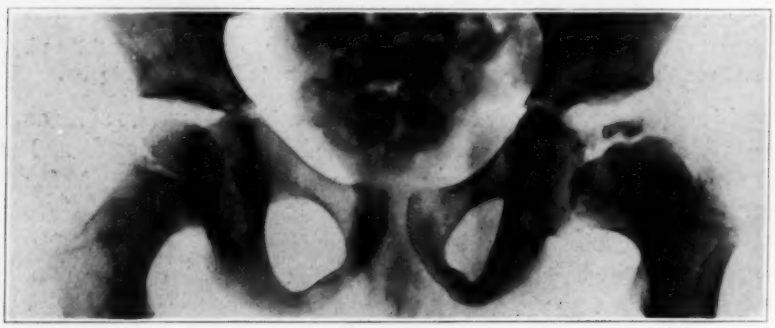

FIG. 6-D

February 9, 1937. Regeneration is beginning in the head.

CASE 6 (*Continued*)

FIG. 6-E

May 10, 1937. Shows marked advance in regeneration.

FIG. 6-F

August 31, 1937. Regeneration is progressing as in other cases.

FIG. 6-G

June 20, 1939. Regeneration is incomplete twenty-eight months after it began. This case was treated by rest in bed for only eight months. This may be the cause of delayed regeneration and the evident deformity of the head and neck.

Case 5: D. B., male, aged three and one-half years, had in May, 1938, an upper respiratory infection and middle-ear infection. At the same time he had a limp and pain in the right leg. After rest in bed for three weeks the pain disappeared but the limp continued. Course of the disease is shown in Figures 5-A to 5-E.

The examination of the first film (Fig. 5-A) caused much discussion. Was it true Legg-Perthes disease or was it the result of a definite infection that occurred when the child had an infection of the middle ear six months before? Gross infection of the hip joint or an infectious epiphysitis was ruled out by the facts that there was but slight limitation of motions, and but very slight thickening through the hip. Both these signs conformed to Legg-Perthes disease, and this diagnosis was made, largely by careful palpation. The blood sedimentation rate was normal. Four months later (Fig. 5-B) there was definite evidence of marked recalcification in the metaphysis, and beginning recalcification in the head. This was but ten months after the onset of symptoms. It suggested that the necrosis began long before the onset of symptoms, or that it progressed more rapidly than usual. Note how the space between the head and the roof of the socket is large in the earlier x-rays, but that it becomes occupied by the regenerating head in the later x-rays. Again the regeneration of the metaphysis precedes that of the head.

Case 6: W. O'B., male, aged five years, had limp and pain for three months before admission on July 7, 1936. This case is illustrated in Figures 6-A to 6-G.

This case shows clearly how the lateral necrosis of the metaphysis is accompanied by corresponding necrosis in the head, and how the last visible portion of the head sits upon a central pillar of bone in the metaphysis. It also illustrates the increased length of the regenerative phase of the cycle which is probably due to the absence of proper treatment by prolonged rest. The residual deformity is also probably due to the same cause.

Case 7: W. P., male, aged seven years, had pain in the hip for one year before the first examination, June 8, 1938. This case is shown in Figures 7-A to 7-D.

This case illustrates a very marked and widespread necrosis in the neck even down to its base. The rather marked deformity (Fig. 7-D) is probably due to the fact that treatment was not begun until one year after the onset of symptoms.

Case 8: S. P., male, aged four years, had pain for three weeks before admission to University Hospital on April 29, 1930. Tuberculin and Wassermann reactions were negative. This case is illustrated in Figures 8-A to 8-C.

This case is interesting because it shows a central conical-shaped necrosis in the metaphysis and neck. It is suggestive of thrombosis of a central vessel. Note how marked are the pathological changes evident within three weeks after the onset of symptoms.

Case 9: R. T., male, aged nine years, was of the Fröhlich's-syndrome type. Three weeks before first examination on July 20, 1939, he had jumped down six feet from a wall,

CASE 7. W. P. (Figures 7-A through 7-D.)

FIG. 7-A

June 8, 1938. Shows necrosis of a large part of the neck.

FIG. 7-B

October 5, 1938. Shows large necrotic area in the neck.

FIG. 7-C

January 5, 1939. Head and neck are regenerating.

FIG. 7-D

May 16, 1939. Metaphysis and neck have recalcified. Head is regenerating well.

CASE 8. S. P. (Figures 8-A through 8-C.)

FIG. 8-A

May 6, 1930. Shows conical necrosis in the neck.

FIG. 8-B

October 3, 1930. This resembles an infarct.

FIG. 8-C

May 7, 1931. Shows partial healing in the neck, but continued disintegration of the head.

CASE 9. R. T. (Figures 9-A through 9-D.)

FIG. 9-A

July 20, 1939. Broad faint band of decalcification extends entirely across the upper part of the neck. Head is slightly smaller and slightly decalcified.

FIG. 9-B

November 25, 1939. Shows marked necrosis extending across the upper half of the neck. Head is more dense.

FIG. 9-C

December 27, 1939. A necrotic band involves large part of neck.

FIG. 9-D

April 11, 1940. Shows marked and rapid healing in the neck, but progressive disintegration of the head.

CASE 10. B. F. (Figures 10-A through 10-F.)

FIG. 10-A

October 14, 1939. There is a band of necrosis across the entire metaphysis. Head is slightly smaller, with decalcification of the outer third.

FIG. 10-B

December 27, 1939. Shows a marked advance in necrosis of the neck and outer portion of the head.

FIG. 10-C

January 8, 1940. A different view showing marked destruction of the neck.

CASE 10 (*Continued*)

FIG. 10-D

March 1, 1940.

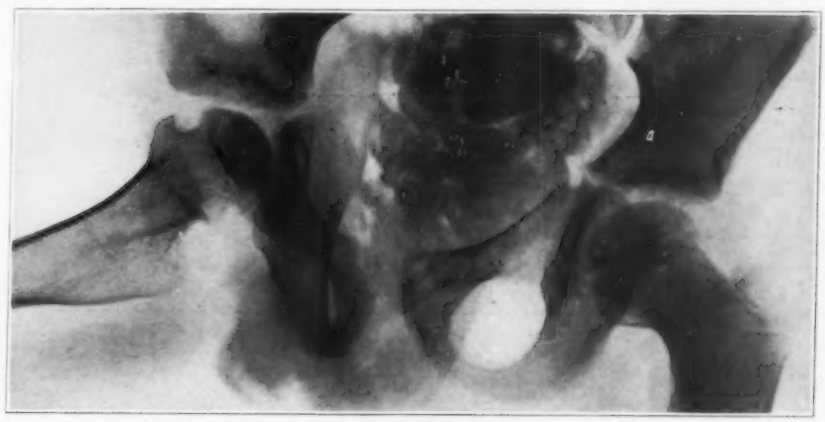

FIG. 10-E

March 1, 1940.

FIG. 10-F

April 11, 1940. Appears to show the beginning of healing in the neck, though outer portion of the head has disappeared.

TABLE I

RÉSUMÉ OF TWENTY CASES OF LEGG-PERTHES DISEASE

Case number	Patient	Age (*Years*)	Sex	Duration of symptoms before first examination (*Months*)	Amount of degeneration shown in first x-ray	Time required to complete degeneration (*Months*)	Time required for regeneration (*Months*)	Regeneration at last report
1	B. G.	5	Male	4½	Moderate	12	19	Incomplete
2	W. C.	6¼	Male	1½	Early	16	12	Incomplete
3	R. E.	7	Female	1	Marked	10	30	Not quite complete
4	G. M.	3½	Male	1½	Marked	11–13	17	Incomplete
5	D. B.	3½	Male	6	Marked	5	10	Incomplete
6	W. O'B.	5	Male	3	Marked	10	28	Incomplete
7	W. P.	7	Male	12	Far advanced	4	14	Incomplete
8	S. P.	4	Male	¾	Marked			
9	R. T.	9	Male	1	Very early	12+		
10	B. F.	7	Male	4	Well advanced	8+		
11*	A. W.	10	Male	1½	Well advanced			
12†	F. M.	4½	Male	3	Advanced	13	17	Incomplete
13†	F. S.	6	Female	18	Far advanced	10+		
14†	M. L.	7	Male	4	Marked	14	8	Incomplete
15†	C. G.	12	Male	24	Far advanced			
16†	A. G.	4	Female	9	Marked	12		
17†	R. C.	4	Male	6	Advanced	11+		
18†	D. D.	5	Male	9	Well advanced	15	12	Incomplete
19†	B. K.	11	Male		Early—untreated		36	Incomplete
20†	E. D.	5	Female	4				

* Discussed in the text as Case 13 on page 1046. † Not discussed in the text.

CASE 11. B. M. (Figures 11-A and 11-B.)

FIG. 11-A

August 31, 1938. Early slipping of the epiphysis. Note area of necrosis in metaphysis and the very slight displacement of the head.

FIG. 11-B

August 31, 1938. Same as Fig. 11-A, but the film is slightly overexposed. Note how the area of necrosis stands out more clearly than in Fig. 11-A.

with resulting pain in knee; a limp developed. Tuberculin reactions were negative, and blood sedimentation rate was normal. The course of the disease is shown in Figures 9-A to 9-D.

This case illustrates the broad bandlike necrosis in the metaphysis and neck which is evident three weeks after the onset of symptoms. The necrotic process progressed for about six months in spite of absolute rest in bed with Buck's extension. Then suddenly regeneration began in the neck.

Case 10: B. F., male, aged seven years, had had a limp for four months, but no pain. Tuberculin reaction was negative. There was a slight firm thickening, but no swelling or tenderness. The case is shown in Figures 10-A to 10-F.

CASE 12. A. D. (Figures 12-A through 12-E.)

FIG. 12-A

October 10, 1934. Shows a bloodless reduction. Head is small and fragmented. There is no evidence of necrosis of the metaphysis.

FIG. 12-B

October 10, 1935. Head appears smaller.

If Case 9 and Case 10 are thought to be examples of slipped epiphysis, they should be compared with the following case.

Case 11: B. M., male, aged ten years, was admitted to University Hospital August 31, 1938, with a typical history and x-ray appearance of a slipping epiphysis. The hip became healed in six to eight months without deformity of the head. See Figures 11-A and 11-B.

Necrosis of the metaphysis is apparently the cause of slipping of the epiphysis. This necrosis appears to be similar to that seen in Legg-Perthes disease (Cases 9 and 10), but it is not accompanied or succeeded by similar changes in the head. The phase of healing in epiphysiolysis occupies a much shorter time than in Legg-Perthes disease. A close inspection of the head (Fig. 11-B) with a magnifying lens appeared to show

CASE 12 (*Continued*)

FIG. 12-C

September 24, 1936. Head is fragmented, but larger. There is no necrosis in the metaphysis.

FIG. 12-D

October 4, 1937. Note the very slow development of the head within the past year.

FIG. 12-E

February 2, 1940. Shows incomplete development, and deformity of head five years after Fig. 12-A.

Case 13. A. W. (Figures 13-A through 13-G.)

Fig. 13-A

May 25, 1935. Shows marked changes in the left hip, early ones in the right. Symptoms were present in the left hip for six weeks, none in right.

Fig. 13-B

February 28, 1936. Patient has been untreated. Very little change has occurred in the left hip since the preceding film. There is a marked advance of the disease in the right hip. Note central necrosis in the neck.

Fig. 13-C

April 28, 1936. Shows evidence of "shelf" operation on the right hip five weeks previously.

CASE 13 (*Continued*)

FIG. 13-D

November 18, 1936. Shows marked deformity of the head, neck, and acetabulum of the left hip (untreated). "Shelf" encloses the right head.

FIG. 13-E

June 22, 1938. Head of the right femur remains in the reconstructed (enlarged) socket.

FIG. 13-F

June 22, 1938. Same as Fig. 13-E, but with legs abducted.

CASE 13 (*Continued*)

FIG. 13-G

January 7, 1939. Shows marked deformity and subluxation of the left hip, sufficiency of the right acetabulum, and less marked deformity three years after "shelf" operation.

very slight evidence of decalcification, but five months later this had disappeared. One can readily conceive that in Cases 9 and 10 the head would have slipped if early treatment had not been instituted. The similarities between Legg-Perthes disease and slipping epiphysis are interesting and will be worthy of further study.

Case 12: A. D., female, aged two years, had congenital dislocation of the hip.

This case illustrates the difference between true Legg-Perthes disease and the somewhat similar condition that frequently is a sequel to congenital dislocation. See Figures 12-A to 12-E.

Case 13: A. W., male, aged ten years when first examined, had symptoms in the left hip of six weeks' duration, but no symptoms in the right. See Figures 13-A to 13-G.

This case illustrates the course of a case not treated by rest, and shows the advantage of the "shelf" operation to make a socket that completely contains the head and gives stability. The right hip did not progress to the marked degree of deformity shown in the left.

SUMMARY

1. Legg-Perthes disease is an affection of the head and neck of the femur which runs a cyclical course. The first, or degenerative, phase of the cycle extends through a period of approximately a year and a half. The second, or regenerative, phase requires two to three years for its completion. Adequate treatment by prolonged non-weight-bearing shortens the cycle, and absence of such treatment prolongs it.

2. The etiology is as yet unproved. The age incidence, in the author's cases, has been between three and eleven years and 85 per cent. have been boys (just the reverse of the sex incidence of congenital

dislocation). Tuberculin reactions have been consistently negative, and the blood sedimentation rate has been normal.

3. The usual symptoms are limp, and pain which is more commonly felt at the knee. The disease is often far advanced at the onset of symptoms.

4. The physical signs are limitation of motion (particularly of rotation) and a slight, but definite, firm thickening of the hip. Occasionally there is slight wasting of the muscles of the thigh.

5. The pathological process is essentially one of aseptic necrosis of the neck and head of the femur which is succeeded by a physiological process of repair.

6. The necrosis is always evident in the metaphysis, and the study of early cases indicates that here is the primary location of the disease. Necrosis of the head follows, and the primary area in the head corresponds exactly to the primary area in the metaphysis. As the disease spreads in the metaphysis, corresponding changes occur in the remainder of the head.

7. Healing occurs first in the metaphysis and later in the head. The corresponding part in each which was the first to show evidence of necrosis is the first to repair.

8. These observations indicate that the disease is essentially one which produces a progressive destruction of the blood supply through the metaphysis and the epiphyseal plate of cartilage, and that the changes which occur in the head are secondary to those in the neck.

9. The deformities that arise in the head and the neck are due to a mechanical crushing of the necrotic tissue caused by weight-bearing and muscle pull. Deformity of the acetabulum is dependent upon the altered shape and position of the head.

10. Treatment by rest in bed with Buck's extension leads to such complete restoration that in the final result it is difficult to detect any deformity of head, neck, and acetabulum.

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GROWTH FOLLOWING FUSION FOR TUBERCULOSIS OF THE KNEE IN CHILDREN

BY S. L. HAAS, M.D., SAN FRANCISCO, CALIFORNIA

From the Shriners' Hospital for Crippled Children, San Francisco

Considerable discussion has arisen regarding the surgical treatment of tuberculosis of the knee in children. One of the arguments against treatment of tuberculosis of the knee joint in children by fusion or resection is the possible loss of growth in the extremity. As about 65 per cent. of length growth takes place at the epiphyseal cartilage plates adjoining the knee joint, there is reason for careful consideration before undertaking operative interference in a growing child. If the epiphyseal cartilage plates of both the lower end of the femur, and the upper end of the tibia are destroyed, there may be a loss of from five to six inches on the affected side.

FIG. 1

Case 7. E. G. Roentgenogram, February 1, 1934. Knee joint before operation.

From the results of experimental resection of knee joints [1] it has been shown that, after the careful resection of the articular cartilage and a layer of cancellous bone, there may be no loss of growth. It was emphasized that the epiphyseal cartilage plate must not be injured during the resection, and the adjoining layer of cancellous bone should be preserved. Since the mechanism of length growth of bones is the same in humans as in animals, one would anticipate that, if the same care were utilized in the operative procedure in man as in the experiments on animals, there would be no growth disturbance from the operation of resection of joints for tuberculosis.

TABLE I

RÉSUMÉ OF TWELVE CASES SHOWING GROWTH FOLLOWING FUSION FOR TUBERCULOSIS OF THE KNEE

No.	Name	Age (*Years*)	Family History of Tuberculosis	Duration (*Years*)	Operations *	Tuberculin Test	Guinea Pig Test	Microscopic Examination	Time Required for Union	Postoperative Shortening	Observation Time (*Years*)
1	G. B.	2¾	Grandfather	1	Nov. 9, 1931 (Exploration) Aug. 7, 1933	Positive (Human and Bovine)	Positive	Positive	2 years and 3 months	Less than ½ inch	4
2	E. Q.	4¼		2	Mar. 16, 1934 Jan. 13, 1936 Sept. 24, 1937	Positive **	Positive	Positive	2 years and 6 months	None	8
3	H. E.	4½		2½	Mar. 16, 1936 Dec. 13, 1938	Positive +++		Positive	2 years	None (½ inch lengthening)	4
4	I. M.	5	Father	2	May 1, 1935 Mar. 24, 1937	Positive ** +++	Positive	Positive	3 years	None (½ inch lengthening)	
5	H. D.	5½	Father	4½	Jan. 30, 1933 (Exploration) Oct. 24, 1934 †	Positive (Bovine) +	Positive	Positive	Fibrous	None	2
6	G. G.	6		4	July 25, 1930			Positive	3 years	None	7
7	E. G.	8		5	Mar. 14, 1932 (Curettement) Nov. 14, 1934	Positive **		Positive	2 years	⅜ inch	3
8	L. R.	8		6	Nov. 13, 1935 Nov. 15, 1937	Positive ** ++		Positive	2 years and 8 months	¼ inch	4
9	S. G.	11		5	July 1, 1935				9 months	None	2
10	R. H.	11		10	July 12, 1933	Positive (Human) +++	Positive	Positive	10 months	None	3
11	C. G.	11½		10½	Feb. 15, 1932 Dec. 6, 1933	Positive (Human and Bovine)	Positive	Positive	1 year	½ inch	2
12	W. W.	12½		8	Apr. 13, 1936	Positive ** +++		Positive	4 months	None	1½

* All operations were for resections except where designated. ** Stock preparation used.

† On January 11, 1935, the patient died at home, presumably of meningitis. Normal healing had taken place in the joint.

FIG. 2

Case 7. E. G. Roentgenogram, taken November 12, 1936, two years after operation, shows the operated femur one-quarter inch longer than the normal. Notice fusion of tibia and femur.

Because of the importance of this problem, it is worth while to study the results of operative treatment, especially if the idea is accepted that only after ankylosis, or the prevention of motion, is a cure of bone tuberculosis almost certain.

At the Shriners' Hospital in San Francisco the author had only a small

FIG. 3

Case 7. E. G. Roentgenogram, taken November 12, 1936, two years after operation, shows that the operated tibia is five-eighths of an inch shorter than the normal.

series of cases of tuberculosis of the knee joint treated by operative fusion. He had, however, an opportunity of observing these patients over a fairly long period of time, with a follow-up of careful measurement, mostly from roentgenograms. The age of the patients at the time of operation covered a representative range from two and three-quarters years

up to twelve and one-half years, and should, therefore, serve as a basis for some valuable conclusions. It is hoped that this short series, added to other reports, will help to answer the questions of the advisability or inadvisability of operative treatment of knee-joint tuberculosis in children.

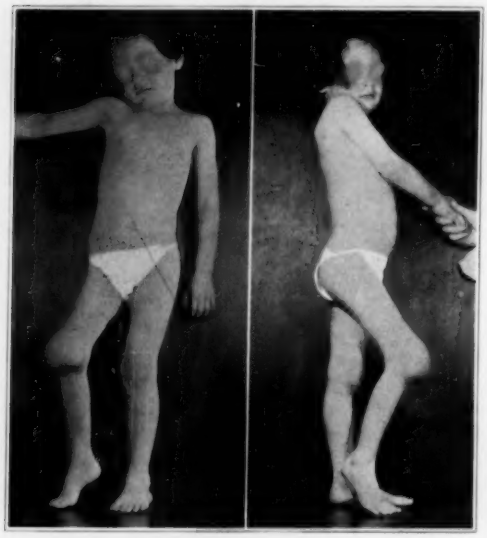

FIG. 4

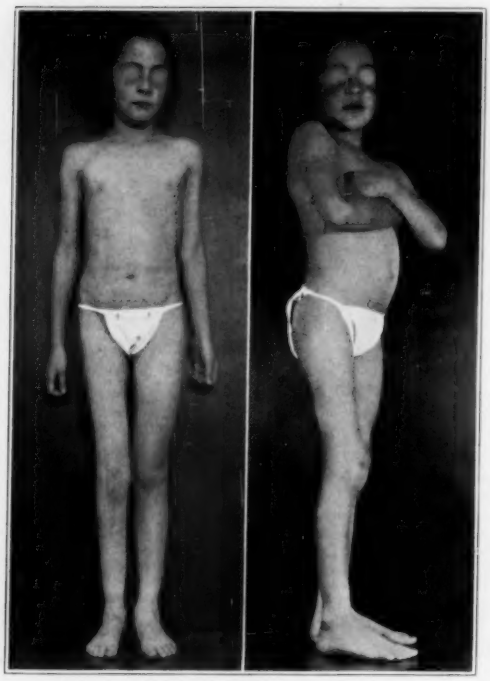

FIG. 5

Case 2. E. Q. Front and side views. Fig. 4 shows condition before operation and Fig. 5 two years after fusion of the knee joint. Notice that the lower extremities appear equal in length.

The operations were performed with a tourniquet through a lateral or medial patellar approach. Whenever possible, the patella was preserved, and, after denuding its undersurface of cartilage, it was transferred to the resected region. After exposing the diseased joint, the remaining articular cartilage of the femur and tibia was removed with as much of the diseased tissue as possible. Particular care was taken to keep away from the epiphyseal cartilage plates of both the femur and the tibia. It was thought better to leave a little diseased tissue, if it extended near the plate, than to remove it, even though another operation might be necessary to secure osseous union. In the very young, where there was a preponderance of cartilage and the ossification center of the epiphysis was small, it was advisable to remove only a thin layer of cartilage, even though a fibrous union might occur. Later, with increased growth of the ossification center it was possible to perform a second operation and secure bony union. In some cases where there was an extreme flexion deformity, a preliminary,

partial correction of the deformity by wedged plaster and other means was carried out. After operation, wherever possible, the limb was placed in a position of extension, because there was the usual tendency for flexion deformity to take place with further growth and overaction of the flexor muscles. The patients were kept in plaster until firm union was secured. Afterward, as an added precaution, they were usually provided with a brace with a molded leather knee cage to be worn for another year.

There were twelve cases in this series of knee fusion in children. The important facts and the results are shown in the table. Figures 1, 2, and 3 are roentgenograms of Case 7 and Figures 4 and 5 show preoperative and postoperative photographs of Case 2.

SUMMARY

The age range of the patients extended from two and three-quarters to twelve and one-half years. In at least three of the patients there was a family history of pulmonary tuberculosis. The duration of the disease varied from one to ten years, being of greater duration in the older patients. The tuberculin test, guinea-pig test, and microscopic findings were fairly uniform at the time of operation; and it is of interest that they were positive even in the older patients. It usually required two operations before a firm, osseous ankylosis took place. It required a longer period in the younger patients than in the older to secure ankylosis. The average time required for bony union in all the patients was about two years. There was no loss of growth in the majority of the patients, and when it did occur it was not more than one-half inch. In some of the patients there was a lengthening after operation due to stimulation of the epiphyseal cartilage plate.

CONCLUSIONS

Arthrodesis of the knee joint for tuberculosis can be successfully performed in growing children as young as two and three-quarters years, without any loss of growth. Care must be utilized not to injure the epiphyseal cartilage plate. Adequate protection to prevent flexion deformity must be provided for several years after operation.

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MALUNION OF FRACTURE OF THE HEAD OF THE METACARPAL BONE (KNUCKLE FRACTURE)

A Simple Operation for Correction

BY EDWARD J. HABOUSH, M.D., NEW YORK, N.Y.

From the Hospital for Joint Diseases, New York*

Although commonly regarded as a trivial injury, "knuckle fracture" may still disable an individual and place before the experienced orthopaedic surgeon a most perplexing task. The difficulties encountered in the treatment of knuckle fractures have been duly emphasized in numerous medical publications by Cotton, Jahss, Jones, Magnuson, and others. The surgical management of knuckle fracture with malunion presents even greater complexities. Reports of such cases are excessively difficult to find.

The purpose of this paper is to review briefly the regional anatomy, to present the pathology of knuckle fractures experimentally produced in cadavera, with comments on their etiology; and to report a case with malunion successfully operated on by a method which the author has not seen described heretofore.

ANATOMY

A metacarpophalangeal joint has no true fibrous capsule, but is invested by a tube of synovial membrane which lines the volar, and the two collateral ligaments. Proximally, the synovial membrane cloaks the neck of a metacarpal bone and forms a dorsal and a volar fold. These folds are comparable to the plica of a tendon sheath, and extend the joint space approximately an inch above the terminal articular surface. Between the dorsal extensor tendon and the synovial roof there is a space normally filled with a very loose areolar tissue. This makes possible the wide excursion of motion of the extensor expansion as it glides over the synovial membrane and smooth dorsal angle of the metacarpal bone.

PATHOLOGY

In knuckle fractures, experimentally produced in cadavera, the skin and dorsal extensor tendon displayed some evidence of trauma. The synovial roof was intact in some instances; in others, one to three small rents were found. These rents were due to the jagged ends of the shaft fragment, sometimes seen protruding through the openings. Dorsally, the fracture was invariably within the joint. Volarly, however, the oblique fracture line was cloaked by the synovial membrane. The distal fragment with its uninjured articular surface and intact collateral ligaments was displaced into the palm laterally and toward the wrist, with a

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FIG. 1

Roentgenograms showing fracture of the second, third, fourth, and fifth metacarpal heads experimentally produced in cadavera. Note injected vessels.

resultant shortening of the metacarpal bone and increase in its antero-posterior and transverse diameters. There was fragmentation of the neck but no real impaction. Proximal to the area of fragmentation, there was the jagged end of the metacarpal shaft (Fig. 1).

ETIOLOGY

Although there have been no experimental determinations on their relative strengths, we know that the metacarpal bones vary in dimension. They gradually diminish in size from the second which is the largest toward the little finger. It seems quite reasonable to conclude, therefore, that the fifth metacarpal is most susceptible to trauma and the second the least.

According to the anatomical texts, flexion is limited at an angle of about 70 degrees. However, upon examination, it will be noted that the fifth finger flexes more than the fourth, and both exceed either the second or the third. Thus, the head of the fifth metacarpal is more readily accessible to injury than the fourth, and both more so than the second or third.

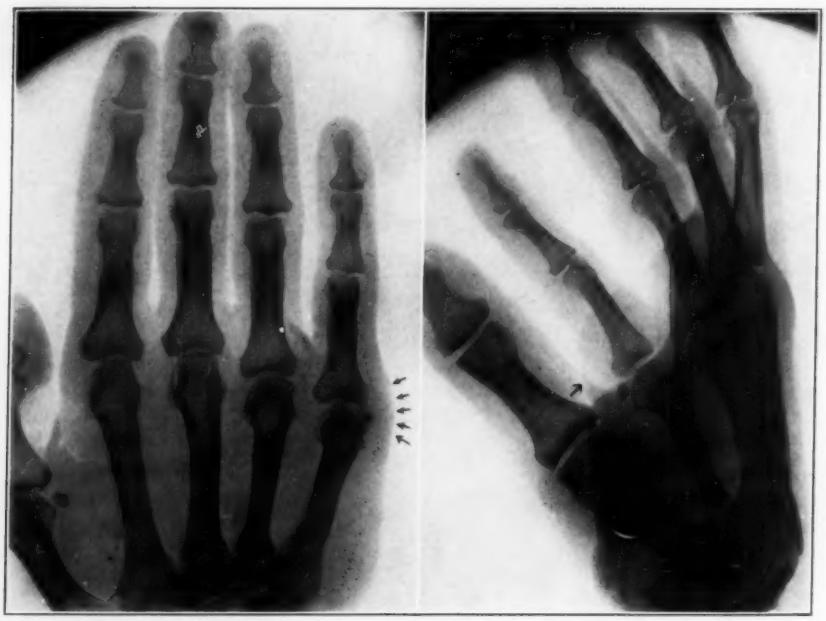

FIG. 2

Preoperative roentgenograms of a malunited fracture of the head of the fifth metacarpal bone. In the anteroposterior view the distal articular fragment is displaced toward the fourth metacarpal, and the jagged end of the proximal fragment is displaced ulnad, causing an increase in the transverse diameter of the head and a resultant soft-tissue prominence on the ulnar side of the hand (see arrows). In the lateral view the distal fragment is displaced into the palm and toward the wrist, with shortening of the head, and an increase in its anteroposterior diameter, causing a soft-tissue prominence in the palm (see arrow). There is a minimum of change in the relationship between the axis of the articular surface of the head and the axis of the shaft of the fifth metacarpal bone. The surfaces of the metacarpophalangeal articulation are intact. Dorsally, the jagged end of the shaft fragment is seen within the joint cavity.

Roberts reports, in 200 knuckle fractures there were 120 involving the fifth; twenty, the fourth; sixteen, the third; and forty-four, the second. This emphasizes the importance of trauma. While the second metacarpal may be stronger and less accessible than the rest, it is traumatized more often than the third or the fourth, but not so often as the fifth.

Experimental evidence tends to show an architectural variation among different individuals rather than a varying of the metacarpals in the same individual. When the architecture of the metacarpals is such that the necks are weaker than the bases, knuckle fractures occur; when the bases are weaker, base fractures occur. Therefore, some persons have a special predilection to knuckle fractures, others to base fractures. The volar articular ridges of the metacarpal heads act as reinforcements and very likely account for the obliquity of the fracture line so characteristic of knuckle fractures.

Ossification also plays a rôle in the incidence of knuckle fracture. During the growth period, until the epiphyses unite with the bodies at

about the end of the twentieth year, the metacarpal bones are probably more susceptible to fractures. Ossification is first to appear and union first to occur in the second metacarpal bone. This may also be of some importance in the occurrence of fracture.

REPORT OF CASE

V. C., a white adult male, aged twenty-two, came to the author May 14, 1936. The patient stated that he had broken the knuckle of the fifth finger of the right hand on November 2, 1934. He complained of a bony prominence in the palm with a weakness of his right hand. The little finger was always in the way, and the patient was constantly striking it against various objects.

Physical examination revealed a prominence of the shaft of the fifth metacarpal dorsally and toward the ulnar side of the hand. The head of the fifth metacarpal was prominent in the palm, and, together with the proximal phalanx, was displaced toward the fourth. Motion at the metacarpophalangeal joint was confined to an arc of about 10 degrees; angle of greatest extension, 175 degrees; angle of greatest flexion, 165 degrees. Extension seemed to be limited by a bony impediment, and flexion by soft-tissue structure. There was loss of power in flexion of the ring and middle fingers. The index finger was unimpaired. X-rays revealed a fracture of the neck of the fifth metacarpal with malunion (Fig. 2).

FIG. 3

Postoperative roentgenograms show the leveling off of the dorsal and ulnar bony-shaft prominences with restoration of a more normal articular contour of the head of the fifth metacarpal bone. The anteroposterior and transverse diameters of the bone have been reduced, and the palmar and ulnar soft-tissue shadow prominences have disappeared (see arrow). Thus a more normal relationship has been established between the fifth metacarpal bone and the flexor and extensor tendons.

Operation:

Through a simple longitudinal incision over the dorsomedial aspect of the fifth metacarpophalangeal joint, the dorsal extensor tendon was found overlying and adhering closely to a dense fibrous-tissue mass. The fibrous-tissue mass, almost fibrocartilaginous in character, adhered closely to the underlying metacarpal bone and synovial membrane of the joint, and obliterated the space, previously referred to, normally filled with loose areolar tissue. This fibrous-tissue mass was a definite barrier to flexion of the finger.

On separating the fibrous-tissue mass from the bone and opening the dorsal synovial roof, the articular surfaces of the joint did not come into view. The metacarpal head was hidden by a ledge of bone projecting dorsally and on its ulnar side. This was leveled off with an osteotome, thus diminishing the anteroposterior and transverse diameters of the metacarpal bone, and reestablishing a normal relationship with the flexor and extensor tendons.

Following closure of the wound, the finger was placed at a right angle with the metacarpal bone. Motion was instituted four days after the operation. Following healing of the wound, physiotherapy was administered.

Six weeks postoperatively there was a normal and complete range of motion with a complete restoration of function of the hand. The head of the metacarpal bone which had been readily palpable in the palm was no longer so after the operation (Fig. 3).

SUMMARY

The anatomy, pathology, and etiology of knuckle fracture have been presented, with a case of malunion successfully treated by a simple operation. The procedure outlined and carried out on the case presented has the advantage of early motion, attacks the seat of the pathology, does away with the bony prominences, diminishes the anteroposterior and transverse diameters of the metacarpal bone, and reestablishes a more normal relationship with the flexor and extensor tendons. The change in the axis of a malunited knuckle fracture is not corrected by this operation, but this distortion may be more than compensated by the motion normally present in the third, fourth, and fifth carpometacarpal joints.

In malunited knuckle fracture, the space between the extensor tendon and synovial roof may be obliterated by fibrous tissue which limits flexion of the finger and impairs function of the hand. In such a case osteotomy, usually done above the site of the pathology, is of little avail, and may only raise the metacarpal head. Arthroplasty with resection of the normally aligned and intact articular surfaces seems contra-indicated. Certainly, in the author's experience, the ends do not justify the means.

SESAMOIDS BENEATH ALL THE METATARSAL HEADS OF BOTH FEET

Report of a Case

BY PAUL W. LAPIDUS, M.D., F.A.C.S., NEW YORK, N. Y.

From the Hospital for Ruptured and Crippled *

The review of roentgenograms of 1,000 feet (by Burman and Lapidus) showed the frequency of inconstant sesamoids given in Table I:

TABLE I

Percentage of Frequency of Inconstant Sesamoids

Fifth tibial sesamoid	16.3
Second tibial sesamoid	3.4
Fifth fibular sesamoid	2.9
Fourth tibial sesamoid	0.7
Third tibial sesamoid	0.4

A fibular sesamoid was not seen beneath the second, third, and fourth metatarsal heads in this series of feet. Recently, however, the writer has had one case with fourth tibial and fibular sesamoids present in the right foot only (Fig. 1).

The author wishes to record another case (Fig. 2) with six sesamoids: the first tibial and fibular sesamoids, and the second, third, fourth, and fifth tibial sesamoids which were accidentally discovered in both feet of a woman thirty-five years old whom he treated in the clinic of the Hospital for Ruptured and Crippled on June 12, 1929, for a strain of the right foot. Unfortunately no roentgenograms of her hands were taken.

Stieda, Grashey, and recently Patterson each reported a case of multiple sesamoids of the foot. Thilenius proved conclusively the presence of cartilaginous anlage for the two sesamoids beneath each metacarpal head in a number of human embryos at about the third or fourth month. This may just as well be applied to the sesamoids of the feet.

With a few extremely rare exceptions the adult human foot has two constant sesamoids beneath the first metatarsal head. Other foot sesamoids must be considered as inconstant.

The reader is referred to an excellent work of Kassatkin for more detailed study of inconstant sesamoids of the human hand and foot. The latter author examined 770 feet and found, roentgenographically or in cadavera, the second fibular sesamoid in 0.2 per cent. of the feet, and the fourth fibular sesamoid in 0.6 per cent.; the third fibular sesamoid was not present in any of his cases. In only five feet of his series were there sesamoids present beneath each metatarsal head, the largest total being

*Service of the late Percy W. Roberts, M.D.

FIG. 1

Roentgenogram of feet of a man about forty years old. Tibial and fibular sesamoids (arrows) are present beneath the right fourth metatarsal head. Note also tibial sesamoid beneath the fifth metatarsal heads.

FIG. 2

Roentgenogram of feet of a woman thirty-five years old. Note a sesamoid (arrows) beneath the tibial aspect of each of the lesser metatarsal heads.

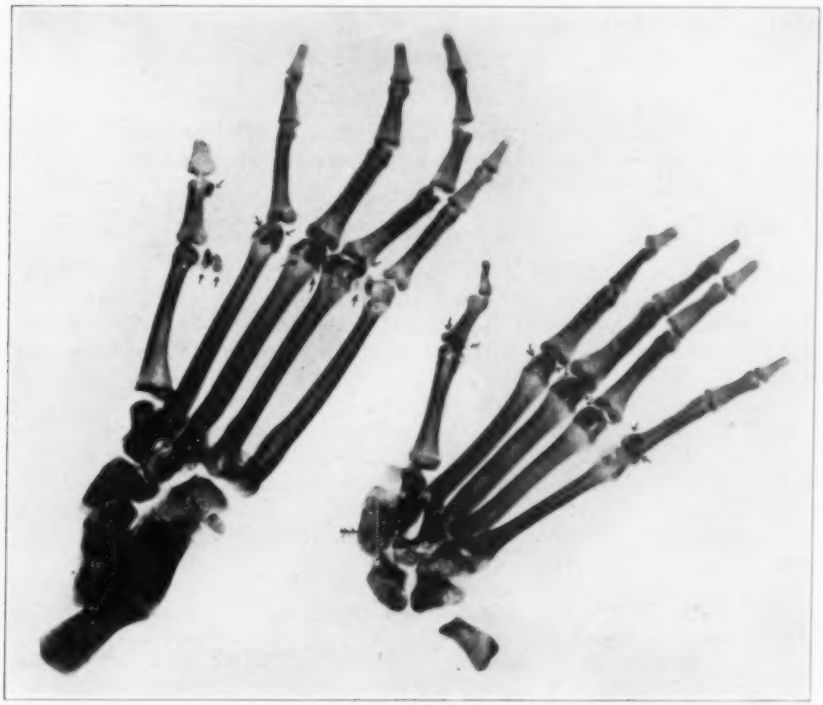

FIG. 3

Roentgenogram of the right foot and hand of a mounted skeleton of an adult baboon. Two sesamoids (arrows) are present beneath each metacarpal and metatarsal head. Note four phalanges of the fourth toe, and also two carpal bones (os naviculare and os centrale, arrow) in place of one human navicular. These two bones are constantly present in the hands of most of the monkeys and may possibly explain the rarely observed congenital division of the carpal navicular in man.

eight sesamoids in one foot: the first tibial and fibular sesamoids; the second and third tibial sesamoids; and the fourth and fifth tibial and fibular sesamoids.

The more frequent occurrence of tibial sesamoids of the second, third, and fourth toes as compared with the extreme rarity of similar fibular sesamoids may possibly be understood if we consider that these sesamoids are located in the tendons of the lumbricales. These muscles run beneath the tibial aspect of the lesser metatarsal heads. The fibular sesamoids apparently fail to develop in human feet. However, this explanation fails to account for the presence of tibial and also fibular sesamoids beneath each metatarsal head in primates which have lumbrical muscles approximately similar to those of the human foot. Possibly the fibular sesamoids of lesser toes in primates are in the tendons of the interossei.

The writer examined, in the New York Museum of Natural History, 320 extremities of various mammals—fifty-six fossils, 192 primates, and seventy-two other mammals—with special reference to the sesamoids.

Two sesamoids were found beneath each metacarpal or metatarsal head (Fig. 3) in almost all adult specimens including fifty-six extremities of fossil animals.

The author wishes to thank Dr. William K. Gregory, Dr. George Pinkley, and Mr. Henry Raven of the Department of Comparative Anatomy of the Museum for their courtesy and assistance during this study.

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OLLIER'S DYSCHONDROPLASIA

Report of a Case*

BY RALPH M. CARTER, M.D., GREEN BAY, WISCONSIN

Typical, frequently occurring disease conditions have generally been thoroughly studied, and are fairly well understood; it is from the atypical cases that much may occasionally be learned. This is particularly true in the field of bone tumors. The establishment of the Registry of Bone Sarcoma, together with improvements in roentgenography and staining technique, have given a decided impetus to the study of these tumors in recent years. As a result much which was formerly obscure has been cleared up. However, our knowledge is far from complete, and from a study of the literature, it appears that this is especially true with regard to cartilaginous tumors. The case which is reported in this paper represents an unusual example of a relatively infrequent disease, and, as such, is considered of sufficient importance to be placed on record.

On September 19, 1938, E. H., a single man forty-seven years of age, came under observation because of a deformity of his right leg.

Inquiry into the development of the condition revealed that the patient was apparently normal at birth, with both legs symmetrical and of equal length. Sometime during his first year, it was noticed that the right leg was not keeping pace in growth with the left, and was becoming misshapen. With the exception of his right leg, the boy developed normally; the deformity and enlargement of the leg continued to increase slowly until about the age of twenty-one, when the condition became stationary. It had remained so until three or four months previous to the time when he first came under observation. Aside from the inconvenience naturally resulting from the deformity, the leg had given him no trouble whatever. The patient himself had made a brace to overcome the shortening, and had always been active in farm work. No fractures had ever occurred. So far as could be ascertained, no hereditary influence was present, and the previous history otherwise contained nothing of significance.

The patient's chief reason for seeking medical advice was because of severe and intractable pain in the heel, together with a gradual enlargement of the tumor in this region. The pain had begun some three or four months previously and had gradually increased in severity until, at the time he was first seen, it was constant, prevented sleep and rest, and rendered him altogether miserable. The increase in the size of the heel had been gradual, but definite.

Upon examination, the entire right lower extremity was seen to be markedly shortened and deformed, so that in a standing position, the foot of the right leg hung but a short distance below the left knee. The circumference of the thigh was approximately twice that of the normal side, with the enlargement greatest in the region of the hip and knee; a similar enlargement affected the leg below the knee. The foot was a monstrosity, the deformity being particularly marked in the region of the heel, which was greatly swollen, with the overlying skin somewhat discolored and scaly. Upon palpation, the swelling throughout was hard and apparently bony in consistency, except about the heel, where some fluctuation could be detected; and, except in this area, where there was marked tenderness upon pressure, was entirely insensitive. No gross deformities were apparent elsewhere in the body, and the general physical examination was otherwise negative. (See Figure 1.)

* Presented before the Western Surgical Association, Los Angeles, California, on December 15, 1939.

X-Ray Findings:

A roentgenographic study of the entire skeletal system was made. The films of the head, upper extremities, spine, and lungs revealed no abnormalities whatever; those of the lower extremity disclosed a most interesting and unusual condition.

The entire right half of the pelvis, particularly the outer half of the ilium, showed a diffuse mottling, apparently the result of abnormal calcium deposition, although some osteoporosis was also present, especially about the rim of the iliac crest. No cystic areas were visible. This condition extended into the acetabular region, and involved the right pubis and ischium, which were somewhat thickened and deformed. The left half of the pelvis was entirely free from change, as were also the sacrum and lower lumbar spine (Fig. 2).

The upper end of the femur was the site of a bulbous enlargement, with deformity of the neck and trochanteric region; here again the mottling was visible. The shaft of the femur was very short, and the general shape of the bone, with another enlargement at the lower end, was that of a dumbbell. Neither in the pelvis nor in the upper end of the femur did the disease process appear to extend into the surrounding tissues. There was apparently no abnormal periosteal reaction in this region.

The lower end of the femur showed a dense rounded mass, in which very little structure was visible. The actual shaft of the femur appeared to be about two inches in length, with the remainder of the bone consisting of the bulbous enlargements above and below. In the lower end of the femur, the process had apparently broken through the cortex, and numerous strands of calcification were to be seen extending out into the surrounding tissues, giving rise to a definite "sun-ray" appearance. The patella was markedly atrophic, but was apparently not involved in the growth. The space of the knee joint was obliterated (Fig. 3).

The same bulbous enlargement was seen involving the upper end of the tibia. Here again there was no definite periosteal reaction, and no calcification or other signs of extension into the surrounding tissues. The fibula did not appear to be involved.

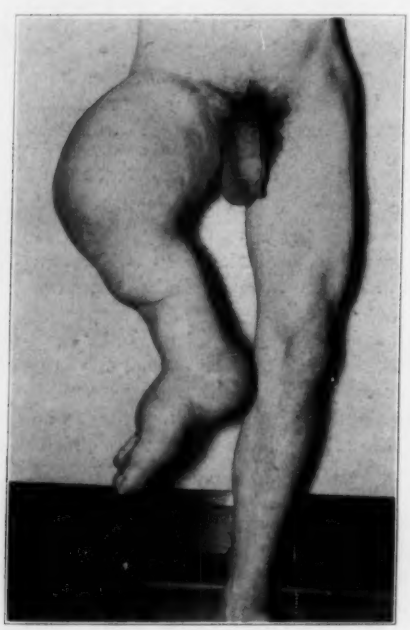

FIG. 1

Deformity of entire lower extremity.

The lower end of the tibia and the foot showed a similar appearance. The posterior portion of the calcaneum appeared cystic, and again the disease process apparently extended into the surrounding tissues, as evidenced by linear calcifications. All the bones of the foot appeared to be involved, with the exception of the fifth metatarsal, but the process was confined entirely to the individual bones, with no breaking of the periosteum, and no soft-tissue involvement (Fig. 4).

Following this examination, a biopsy was requested, but refused. It was recognized that the apparent tumor masses were probably cartilaginous in nature, and were possibly undergoing malignant changes in certain areas. The only treatment recommended was a course of x-ray therapy, in the hope that the pain might thereby be relieved. This was given, with no effect whatever on the pain, and no apparent effect on the tumor tissue.

The patient was lost sight of until January, 1939, four months after he was first seen. During the interval, the pain had become increasingly severe, and he was insis-

tent that something be done. Although it was recognized that it might prove only palliative, especially in view of the wide distribution of the tumor masses in the pelvis, amputation of the extremity was advised, and on January 25, 1939, a disarticulation at the hip joint was performed. He made an uneventful recovery, and at the present time (May 15, 1940), is in excellent health, so far as can be determined by physical examination. A recent roentgenogram shows no apparent change in the disease process in the pelvis (Fig. 5).

Pathological Examination:

The pathological examination of the extremity was made by Dr. H. Heitzman, Pathologist for the Bellin Memorial Hospital in Green Bay, to whom the author is indebted for the following report:

"The specimen consisted of an entire right lower extremity 58 centimeters in length. Longitudinal section of the femur [Fig. 6] revealed a definite compact bone cortex 0.2 centimeters in thickness in the proximal half. The spongy bone was firm with scattered areas of pale blue hyaline cartilage, 0.2 to 1.0 centimeters in diameter. The marrow was red. The distal femur revealed the periosteum greatly expanded by a large soft cartilaginous mass which extended to the knee joint with irregular thin plates of bone scattered throughout. Compact bone was present near the anterior surface, with the largest amount of soft cartilage projecting posteriorly. Fibrous septa radiated into the cartilage.

"The sectioned patella showed spongy bone, fatty marrow, and numerous hyaline cartilage masses 0.2 to 0.5 centimeters in diameter.

"The dumbbell-shaped tibia revealed a definite compact bone cortex throughout the shaft. Section revealed areas at both ends of the shaft with firm spongy bone, fatty marrow, and no cartilage. Immediately adjacent to these areas were two others, ap-

FIG. 2

Roentgenogram of pelvis and upper end of femur, showing involvement by tumor.

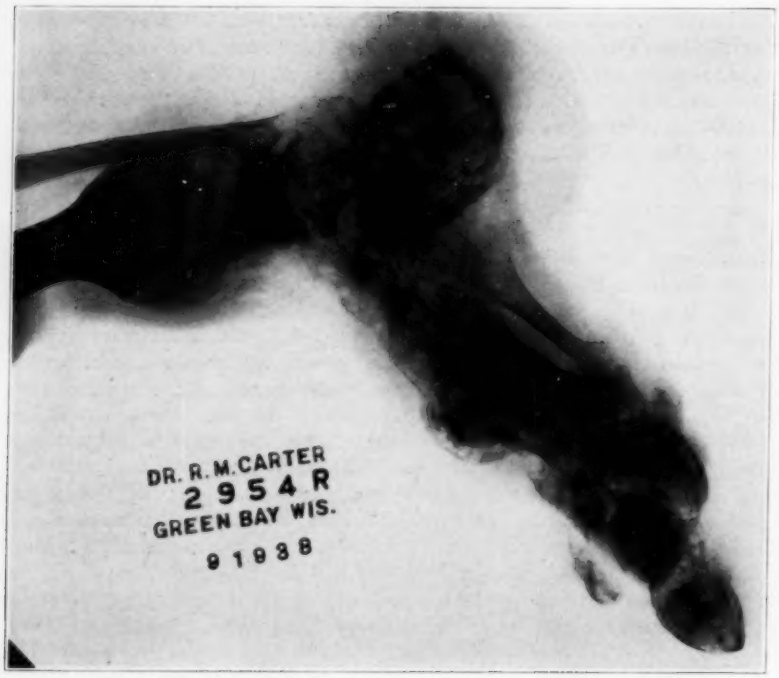

FIG. 4

Roentgenogram of lower end of tibia and foot.

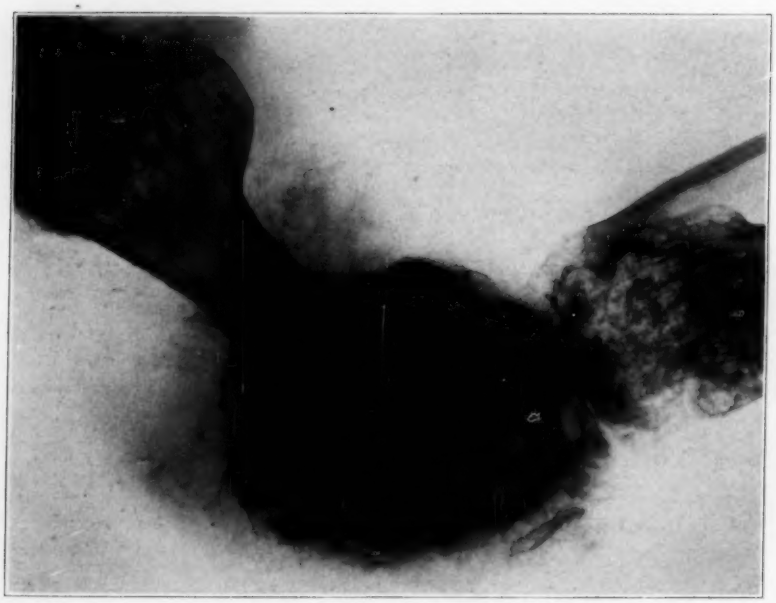

FIG. 3

Roentgenogram of lower end of femur, knee joint, and upper end of tibia.

FIG. 5
Roentgenogram of pelvis after operation.

proximately 6 centimeters in length, which showed numerous hyaline cartilage masses, thin plates of spongy bone, and dense nodules of compact bone. The midshaft revealed no cartilage, and only slight, or no abnormality in the compact or spongy bone.

"The fibula was slightly shorter than the tibia with no external abnormality except slightly enlarged ends. Section revealed small hyaline cartilage masses in the spongy bone of the enlarged ends.

"The entire calcaneum for the most part consisted of a spherical mass of soft cartilage containing small irregular plates of bone. The periosteum could be easily followed about the entire mass, and separated easily from the subcutaneous tissue. No extension through the periosteum was present. Section revealed a flat, opaque gray surface composed of soft cartilage, with a small amount of dark brown blood in the center.

"The other bones of the ankle and foot revealed similar changes, with the relative amount of cartilage showing some variation. Throughout, the muscles were the seat of atrophy, fibrosis, and fat infiltration. The veins were thin-walled, with no invasion by tumor.

FIG. 6
Sectional view of gross specimen.

"Upon histological examination, all sections from the distal femur and the calcaneum were similar. The periosteum was intact at the periphery, with immature cartilage the most abundant substance. The intercellular substance varied from coarsely granular to a homogeneous material. There was much variation in the size of the pleomorphic cells, many of which had numerous long processes. Cytoplasm was abundant, vacuolated, and frequently contained large, acidophilic hyaline masses. The nuclei were large, oval, irregular, vesicular and eccentric. Binucleate cells were frequent. A large, single basophilic nucleolus was present. Mitotic figures were not seen.

"Small plates of bone occurred throughout the immature cartilage. Osteoblasts varied in number. Few osteoclasts were present. Thin-walled blood vessels occurred. No invasion of the blood vessels was seen.

"Sections from the proximal tibia revealed a more mature type of hyaline cartilage, with small irregular foci of bone platelets."

DISCUSSION

There remain to be briefly discussed, first, the diagnosis, and second, of particular interest and importance in this case, the prognosis. Taking into consideration the onset in early life, the apparent original localization of the cartilaginous masses in the epiphyseal regions of the long bones, the benign course, and the histological appearance of the tissue, the condition appears to be one of Ollier's dyschondroplasia. Dr. D. B. Phemister, of Chicago, who reviewed the roentgenograms and sections of the tissue, concurred in this diagnosis.

The disease is one affecting bone formed in cartilage, and was described in 1899 by Ollier as dyschondroplasia. At the epiphyseal line, the cartilage proliferates normally, but normal degeneration and calcification, and therefore, ossification are prevented. In consequence, as the bone grows in length, there persist in the diaphysis masses of unossified cartilage. Apparently, as in this case, these masses of cartilage may occasionally take on independent growth, until huge tumors are formed. Also occasionally, according to Hunter and Wiles, sarcomatous change may supervene.

Assuming Ollier's conception of the disease to be correct, it seems apparent that it is not a true neoplasm in the strict sense of the word; but rather is the result of disturbance of the physiological processes of bone growth and development, due to undetermined factors. These disturbances may exist in localized areas, side by side with normal bone development; as a result of this, deformities are produced. In other words, if this theory is true, the deformities result from a retardation of growth of certain portions of a bone, with normal growth in other portions of the same bone. Under these circumstances, the deformities present in the majority of cases of Ollier's dyschondroplasia rarely attain the extreme degree seen in the case which has just been described.

In this case, to produce the gross malformation which the patient presented, the cartilaginous "rests", if they may be so called, must have taken on independent growth, and this, too, greatly at the expense of the normal bone-producing portions. This is particularly true at the upper and lower ends of the femur, upper end of the tibia, and the calcaneum.

In these regions, at least, the tumors appear to approach very closely the character of true neoplasms, or enchondromata.

Finally, in this particular case, there has to be considered the question of malignancy. From the roentgenograms of the lower end of the femur and of the calcaneum, it seems apparent that the growth has broken through the cortex of the bone, and is invading the surrounding tissues. This, in itself, suggests that the tumors are not benign, at least in these particular regions. However, this roentgenographic appearance is not borne out by actual examination of the tissues. As was stated in the pathological report above, the periosteum everywhere appeared to be intact. The history of renewed growth after a long period of quiescence in the region of the heel is also significant. On the other hand, from the histological examination of the tumor tissue, no definite conclusions can be drawn; likewise no invasion of the blood vessels can be demonstrated.

In this connection, Phemister writes as follows:

". . . The interesting feature to me is the cartilaginous overgrowth about the periphery of the central expansile mass at the end of the shaft of the lower part of the femur and os calcis. Considered separately, these lesions look like chondrosarcomatous developments in the x-ray and histologically the tissue is compatible with chondrosarcoma. However, growing, benign cartilaginous tumor and chondrosarcoma are very difficult to differentiate microscopically. Consequently I wouldn't want to say that malignancy had set in here unless the patient subsequently develops a metastasis."

Heitzman of the Bellin Hospital was likewise unable to express a definite opinion as to the presence or absence of malignancy, and apparently the question can only be decided by the future course and outcome of the disease.

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REPAIR OF OLD RUPTURE OF THE TENDO ACHILLIS BY MEANS OF FASCIA LATA

Report of a Case

BY ISADORE ZADEK, M.D., NEW YORK, N. Y.

Complete rupture of the tendo achillis is a rare lesion. It is surprising that it does not occur more frequently. Partial rupture of the tendo achillis is not so rare, and partial rupture of the calf muscle, usually considered as a rupture of the plantaris, is relatively common.

H. G. G., aged thirty-seven, was first seen by the author on September 8, 1937, complaining of trouble with his left leg. He was a director of activities for boys, and had been accustomed to doing acrobatic stunts for many years. One month before he was seen, he was doing a stunt which he had done for many years called a "balking mule", in which he snapped his body forward and backward with his hands in contact with the floor. On this particular occasion, the patient experienced sudden pain in the region of the left heel cord, and felt as though he had been struck with a baseball bat. He had to stop stunting at once. On the day of the accident, he had a great deal of discoloration about the ankle. He gradually began to walk with the affected extremity in outward rotation. The accident occurred during vacation, and two weeks later the patient drove his car 1000 miles. When driving, he pushed in the clutch pedal with his heel, and when walking, he used two canes. He was unable to place his left foot firmly on the ground and could not flex it.

When he first consulted a doctor, two weeks after the injury, he was given massage, but failed to improve. The depression in the heel cord, which had previously existed, had grown deeper, and he had lost power in his calf muscle. He felt able to walk only upon his heel. He was forced to use crutches for the first time on the day he was seen by the author.

Examination: His general condition was good. He walked with crutches and had a marked limp on the left side. There was a wavy depression three-fourths of an inch wide in the course of the tendo achillis, beginning two inches above the upper border of the os calcis. He was not sensitive at the site of rupture. He had completely lost the power of plantar flexion of the left foot. The calf showed only slight atrophy. His foot was otherwise negative and circulation in the foot was good.

Diagnosis: A diagnosis of old rupture of the left tendo achillis was made, and operative repair with fascia lata was advised.

Operation: The patient was operated upon on September 9, 1937, at the Mount Vernon Hospital. The tendo achillis was exposed through a six-inch incision, and was found completely torn. The lower end of the upper portion was conical in shape, and the upper end of the distal fragment was bulbous and redundant. There was no tendinous tissue inside the sheath at the site of the defect. In other words, the rupture was complete. The gap, an inch and a half wide, was larger than it had seemed clinically. After the two ends of the torn tendon had been freshened by cutting away the abnormal portions, there was a gap of about three inches, with the upper portion of the defect at the musculotendinous junction. No separate sheath could be identified.

Three strips of fascia lata, one-half inch wide and six inches long, were taken from the left thigh. The upper portion of the tendon was split in a sagittal plane and the lower portion in a coronal plane. The strips of fascia lata were woven into the split portions of the tendon, sewed to each other, and sutured under slight tension with heavy chromic gut. The other deep soft tissues were closed with chromic gut, the subcutaneous tissue with

plain catgut, and the skin with silk. With the foot in slight equinus a plaster-of-Paris cast was applied extending from the toes to the knee.

On September 20, 1937, the plaster-of-Paris cast was removed, and a new walking cast was applied, extending from the toes up to the knee with the foot at a right angle. At this time he showed fair power in the calf muscle.

On September 23, 1937, he was discharged from the hospital, walking with crutches and bearing his weight. His further course was uneventful. Five weeks after the operation, he was fitted with an ankle brace with attached foot piece, allowing limited motion, which he used for five months.

FIG. 1-A

Showing the tendo achillis as found at operation.

Patient was last seen by the author two years after the operation. He stated that he could do his usual athletic stunts as well as he had prior to the injury, and he had no pain. He was able to play eighteen holes of golf without strain or discomfort, run, and play basketball. At this time, he had motion in the left ankle from 80 to 130 degrees, compared with 80 to 135 degrees in the right. He showed excellent power in the left calf muscle; walked without limp; and could rise on the toes of his left foot and bear his weight without difficulty. There was no local sensitiveness. He demonstrated the "balking mule".

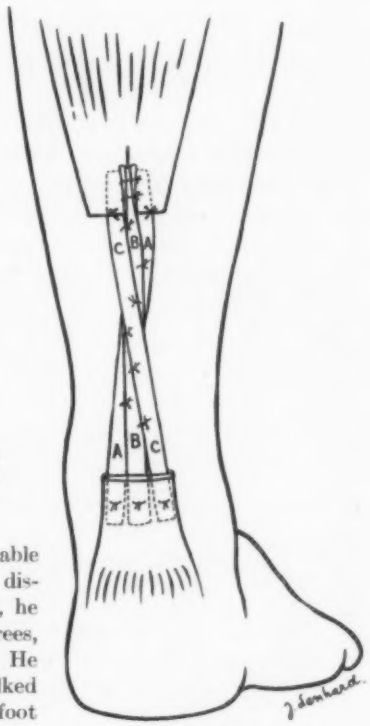

FIG. 1-B

Method of repair by the use of strips of fascia lata.

FIG. 2

Two years after operation. Patient standing on a stool, and bearing weight on the left forefoot. The outline of the reconstructed tendon is clearly evident.

FIG. 3

Two years after operation. Patient bearing weight on the left forefoot as seen from the side.

A SIMPLE METHOD OF REDUCTION AND FIXATION OF COMPRESSION FRACTURES OF THE SPINE

BY EDWARD PARNALL, M.D., MINOT, NORTH DAKOTA

From the Department of Bone and Joint Surgery, Northwest Clinic, Minot

Within the last dozen or fifteen years the hyperextension mechanism for treating compression fractures of the vertebrae has been evolved and variously elaborated. The most profound comments on this mechanism were made by Davis.[1]

For the maintenance of tension, a satisfactory body cast, holding the spine in hyperextension, is a prime requisite. Probably one of the most efficient ways of getting proper hyperextension would be to arch the patient's trunk backward over a barrel. But alas, a barrel can be neither comfortably incorporated in a cast nor conveniently slid out of it. Application of a cast with the patient supine on a canvas hammock can only be condemned, since in using it one can achieve neither the sharp degree of hyperextension necessary, nor fit the plaster comfortably around the pubes and clavicles. Some methods seem rather precarious (Watson-Jones), and others require apparatus that entails quite an expense (Rogers frame). The original—and probably the most efficient—method of Davis[1], suspension by the heels in supine position, is simple, but uncomfortable for a conscious patient, and difficult for the surgeon when he applies a cast instead of anteroposterior shells.

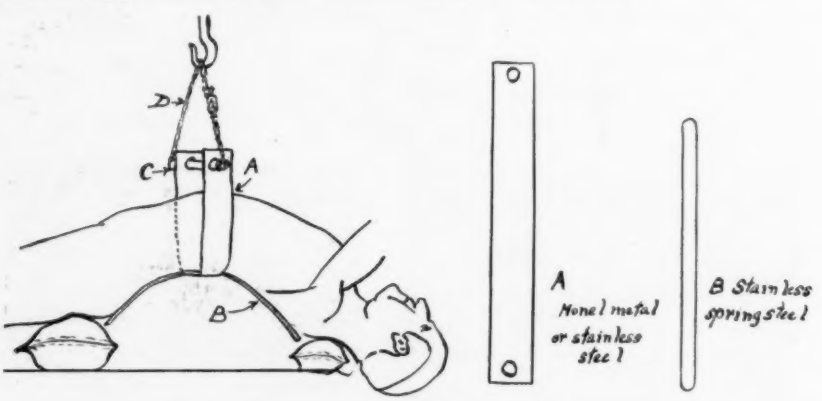

FIG. 1

The author has found the following method simple and inexpensive, with a fulcrum of curvature that can be accurately adjusted to whatever lumbar or thoracic vertebra is involved.

The apparatus (Fig. 1) consists of a block and tackle, suspended from an adequate overhead fixation point; a thin band (*A*), about forty or forty-five inches by three and one-half inches; two strips of spring

steel (*B*), about one inch wide and thirty inches long; a cross bar (*C*) of ordinary one-inch pipe; and a length of stout rope or sash cord (*D*). Holes, to receive the ends of the cross bar, are drilled in each end of the band, which is made of monel metal, stainless steel, or other non-malleable metal which retains its smooth surface.

The patient is placed in a supine position, upon adequate felt padding, with the two spring-steel strips, which have been coated with a thin film of mineral oil, placed underneath, one on each side of the spinal column. The wide metal band is then slid across, underneath the whole, at the level of the compressed vertebra, and the ends brought up on either side. The ends of the pipe cross bar, with the sash cord threaded through it, are put through the holes in the band, the cord made fast, and the patient pulled up with the block and tackle until he swings clear of the table. Sand bags may then be put under the shoulders and buttocks to steady him. While the patient is well hyperextended across the suspension band, the two longitudinal strips prevent too exaggerated a degree of angulation, and make the curve smooth and comfortable. A long body cast reaching from the symphysis pubis to the sternal notch is applied in the usual manner. When the cast is set, the strips are easily slipped out.

FIG. 2

Two weeks after reduction and application of cast. Note that cast reaches from sternal notch to the symphysis pubis, and fits snugly under the axillae.

The duration of recumbency following application of the cast is a matter of judgment, and may be anywhere from one to six weeks. In general, a tall, heavy man with a long trunk will require a longer time than a short, light person, since the apophyses of the former cannot be depended upon so confidently to sustain the weight without some collapse of the vertebral body. Lateral roentgenograms are the most reliable check on the condition from time to time. A properly placed window on each side permits the observance of bone detail, and in no way spoils the efficiency of the cast. The writer does not employ any steel back brace, since the best of them does not really immobilize a spine. This apparatus, however, makes it quite easy to change casts as often as desired, so that immobilization may be continued for six months or longer if necessary.

While this method offers no radical departure from the principles laid down by Davis, and the results attained by its use in no way differ from the usual end results of *proper* hyperextension and immobilization, the apparatus can be used for nearly all compression fractures, with or without cord involvement. Its chief advantage is security at all stages of operation, with delicacy and accuracy of adjustment.

An important contra-indication to its use, however, is any fracture of a posterior arch at the point of fulcrum desired, which may be further injured by such stress. In such cases the Davis or Watson-Jones method is the one of choice.

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TUBERCULOSIS OF THE GREATER TROCHANTER AND TROCHANTERIC BURSAE

BY JOSEPH D. WASSERSUG, M.D., MIDDLEBORO, MASSACHUSETTS

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Tuberculosis involving the greater trochanter or the trochanteric bursae is still regarded as rare although more than seventy-five cases have been reported in the literature. Of 1,017 cases of bone and joint tuberculosis admitted by the Lakeville State Sanatorium, during the twelve-year period from 1928 to 1939, eighteen cases of trochanteric disease were found, an incidence of 1.8 per cent. Peabody [10] found that in the Massachusetts General Hospital from 1870 to 1920 the diagnosis of tuberculosis of the trochanter was made just five times.

In this series of eighteen cases, five had disease only in the trochanter; no other focus could be found. In two cases, the bursae alone were involved, and there was no evidence of a trochanteric bone lesion.

Tuberculosis of the trochanter occurs most commonly in young adults. Perrin [11] described a case in which the trochanter was involved in a boy three and one-half years old, the youngest of any of the reported cases. The average age of onset of symptoms in the present group of cases was twenty-five and one-half years, with the ages varying from seven to fifty-five years.

A greater number of cases occurred in males than in females. There were thirteen males and five females.

The left side was involved in thirteen cases, and the right in only five. This differs from the observations of Meyerding and Mroz [9] who found disease on the right side in fourteen out of nineteen cases. Apparently the disease occurs with about the same frequency on either side.

Of the eighteen cases studied, a history of local trauma was obtained in nine. In two additional cases, trauma resulted in an exacerbation of arrested lesions. The interval between traumatization and onset of symptoms varied from two months to fifteen years, with an average period of six and one-quarter years. This is essentially in agreement with the figures cited in the literature.

The presence of a demonstrable tuberculous focus is a second etiological factor. Only five of the eighteen cases had no demonstrable lesion other than the trochanteric disease. In thirteen, or 72 per cent., other tuberculous lesions were found. Of these thirteen, a history of trauma was obtained in six. Of the five cases in which no tuberculous focus could be demonstrated, three gave a definite history of local injury.

DIAGNOSIS

The diagnosis of tuberculous trochanteritis is not simple. It is frequently mistaken for other conditions about the hip, and has been con-

fused with osteochondritis deformans [1], lipoma [3], tuberculosis of the hip [5], Pott's disease [4], neoplasms of the femur [7, 10], and hematoma [8].

Pain in the region of the hip is the most common symptom, and it was the presenting symptom in fourteen of the eighteen cases. In the remaining four cases, the initial complaint was the appearance of a lump or abscess in the vicinity of the trochanter. The development of a sinus is common, but the diagnosis can usually be made before this complication occurs. Eleven of the fourteen patients who complained first of pain subsequently developed a swelling over the trochanter. The pain experienced is usually intermittent, but may later become continuous; it is relieved by rest, and aggravated by walking, exercise, and change of posture. In two cases, damp weather aggravated the pain in the hip.

Examination may yield but little information and, in the presence of characteristic symptoms, the absence of positive signs of hip disease is strongly suggestive of trochanteric involvement. The patient does not lie or stand in any characteristic attitude, but he may limp slightly. There is never any shortening, and atrophy of the thigh muscles is unusual. There may be some local swelling, but, until an abscess is about ready to discharge, there is no local heat or redness. Local tenderness, however, is a very common finding, and the tenderness is usually directly over the trochanter. Generally, movements at the hip are not restricted or painful. Even with extensive swelling in the region of the thigh, hip motion is fairly free.

In the majority of cases, roentgenograms are indispensable. In some cases, however, when x-ray examination is done early in the disease, or when the bursae alone are involved, the roentgenogram may be of no help. In a few other cases roentgenographic study may be definitely misleading. Differentiation between tuberculosis of the trochanter and neoplasms of the femur is sometimes exceedingly difficult. In this series of cases, roentgenograms revealed bone destruction in every case where the trochanter was involved. Occasionally, in obscure cases, the injection of a radio-opaque substance into a sinus leads to a correct diagnosis.

The diagnosis of tuberculous disease should be confirmed by bacteriological or histological methods or both. Guinea-pig tests should be made on all fluid obtained by aspiration, and on material draining from sinuses. Rarely, guinea-pig tests on fluid obtained in this way may be negative, and yet material from the abscess wall may be characteristically tuberculous. Sixteen of our cases were operated upon, and the diagnosis was confirmed in fifteen. In the remaining case, smear and culture of aspirated fluid were negative, but the diagnosis was later confirmed at autopsy.

Of the fifteen cases confirmed at operation, ten were confirmed histologically, two bacteriologically, and three by both methods. The two cases which were not operated upon had extensive bone and joint, pulmonary, or urogenital tuberculosis, and the diagnosis was made on roentgenographic evidence.

In all cases, the tuberculin test was positive, and the blood Hinton negative. In no case was there a history of tuberculosis in the family or a history of contact.

TREATMENT

There is unanimity of opinion that surgical intervention is preferable to conservative treatment. Chakir [2] and Herlyn [6] believed that operation shortened the duration of the illness, and that delay led to the development of fistulae. Meyerding and Mroz [9] felt that the treatment should be radical excision as soon as the diagnosis is made. This viewpoint is corroborated by our study.

The eighteen patients in our series had a total of forty-three operative procedures performed for their trochanteric disease. These were three aspirations, four sequestrectomies, six curettements, seven biopsies, eight excisions or resections, and fifteen incisions for drainage. Two patients were not operated upon at all; one was operated upon five times. Incision and drainage were done as a palliative measure for two patients too poor a risk for further surgery, both of whom died. In a third case, incision and drainage, but no other operation, were done on three different occasions, and the drainage from sinuses has persisted for more than twenty-five years. Incision was done only once in eight other cases and in seven of them further operation was required. The eighth patient still has a discharging sinus three years after his original incision and drainage. Thus, incision and drainage, which are so commonly done, appear to be without any permanent benefit.

Radical excision, resection, or thorough curettage gives superior results. Such operations were performed in ten cases, and in no case was there drainage or sinus at the time of the patient's discharge from the hospital. Six of these patients were followed for an average period of four years after leaving the Sanatorium, and none of them had any recurrence of swelling, drainage, sinus formation, or spread of the disease.

In most cases, plaster immobilization of the hip is unnecessary. When there is no evidence of hip-joint involvement, little is to be gained by the use of plaster. On the other hand, post-operative cases sometimes benefit from a plaster cast, because of the protection it affords. There were two cases in the series that were not operated upon, and the only treatment given was immobilization in plaster. Both had serious tuberculosis in other organs of the body. One was in plaster for six months; the other, for one year. In both cases, the end results were satisfactory.

END RESULTS

Tuberculosis of the trochanter must be regarded as a serious and disabling illness because of its chronicity and the necessity for prolonged or repeated hospitalization. Of the eighteen patients in this study, four are at present still hospitalized. The remaining fourteen patients stayed at the Sanatorium a total of twenty-one and one-quarter years, or an

average of one and one-half years. The shortest stay was six months; the longest almost six years. Of the fourteen discharged patients, four have died. Eight of the remaining ten have been followed periodically for a total of twenty-three and one-half years, or an average of three years each. Even the five patients who had no tuberculous disease other than the trochanteric involvement remained in the hospital an average of thirteen months. Each of these patients has been followed for an average of four years since leaving the Sanatorium. Except for one of them who became insane and died, all are in good health, and have practically no complaints referable to the trochanter. The patients with the trochanteric bursitis are also free from symptoms.

The prognosis in uncomplicated trochanteric disease is good. The disease has no mortality *per se*. Two patients, who had extensive and multiple tuberculous foci, died while in the hospital. A third death occurred in a sixty-year-old man, six months after transfer to a hospital for the insane. The fourth patient, a man sixty-eight years old, died of cerebral hemorrhage, eleven months after discharge.

ILLUSTRATIVE CASE

W. F., a forty-one year old male, first complained of pain in the left hip in January 1930. The pain was worse at night, and was aggravated by getting up from a seated position. About two months previously, he had received a blow on his left side. He walked with a limp, and a fluctuant mass was felt over the left trochanter. Motion of the hip was somewhat restricted. Roentgenograms showed almost complete destruction of the left greater trochanter, and numerous dense fragments of bone in the soft tissues. After one week of bed rest, the patient was able to get about without pain, and refused operation. He remained relatively symptom-free for three years.

In February 1933, patient again complained of severe pain, and the presence of a mass in the left upper thigh. Examination revealed slight atrophy of the thigh and the presence of a cystic bilobular abscess in the upper thigh region. This abscess of the

FIG. 1.

W. F. Roentgenogram taken six months after operation. Note complete absence of left greater trochanter. Excellent functional result was reported six and one-half years later.

left greater trochanter was incised, drained, and thoroughly curetted. Pathological diagnosis was tuberculosis. Postoperatively, patient was given a Thomas splint, and was transferred to the Lakeville State Sanatorium.

On admission, March 3, 1933, he had a healed scar on his left thigh. All movements of hip were free, non-painful, and non-restricted. Roentgenogram showed left greater trochanter surgically removed, and several rarified areas in the neck of the femur, adjacent to the greater trochanteric region. Patient was given a short single plaster spica, because it was felt that there might be extension of the disease into the femoral neck. Three months later, he was allowed out of bed, and his improvement continued until September 17, 1933, when he was discharged (Fig. 1).

In February 1940, six and one-half years after discharge, patient had no pain, swelling, lameness, or sinus formation; movements at hip were not restricted. He had been steadily employed as a mattress-maker.

SUMMARY AND CONCLUSIONS

1. Eighteen cases of tuberculosis of the greater trochanter and the trochanteric bursae are analyzed.

2. Fifty per cent. of these cases had a history of local trauma; in 72 per cent. there were one or more other demonstrable tuberculous foci.

3. The diagnosis of trochanteric tuberculosis is frequently missed because there is no characteristic clinical or roentgenographic picture.

4. Radical surgical treatment is preferable to prolonged conservative measures.

5. Tuberculosis near the hip joint is serious because of its chronicity and the necessity for prolonged hospitalization.

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ASEPTIC NECROSIS OF BONE OCCURRING IN CAISSON DISEASE

A Case Report

BY WILLIAM A. WALKER, M.D., NEW YORK, N. Y.

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The subject of aseptic necrosis of bone occurring in caisson disease was reviewed by Kahlstrom, Burton, and Phemister [1] a year ago, and four cases were reported by them. They were the first to give the pathological findings in the late bone changes in this condition. This they did by autopsy in one case and biopsy in another. They concluded that, in caisson disease, nitrogen-bubble emboli in the blood stream caused infarction with subsequent aseptic necrosis of intramedullary bone. Since fat absorbs five times as much nitrogen as blood plasma, long bones were involved because of the higher fat content of the yellow bone marrow. The cortex was spared because of its richer blood supply.

Later changes in the process following necrosis were reparative in nature. Within the shafts of long bones the necrotic area was surrounded by a fibrous wall which went on to calcification and ossification. At the same time there was some replacement of dead bone by invasion of new bone. These processes went on until the strength of the bone had reached normal. When a weight-bearing epiphysis, such as the head of the femur, was involved, there was early collapse followed by repair by means of new bone invasion and replacement, and calcification of non-substituted portions. Sections through the diaphyses revealed areas of grayish and brownish debris surrounded by an encapsulating wall of calcified fibrous material, while those through the head showed bone with areas of varying density but no areas of debris.

The case here reported is in all respects similar to those reported by these other named authors.

E. M., a white male, fifty-five years of age, Finnish by birth, and a carpenter by occupation, was admitted to the Orthopaedic Service at Bellevue Hospital on September 2, 1939. His chief complaint was pain and stiffness of the right hip of twenty-five years' duration.

The patient had gonorrhea thirty years ago; denied having had lues; and never had rheumatic fever. He fractured his right leg and hip twenty-three years ago; and was thought to have had appendicitis sixteen years ago, but he believes that the pain was from his hip. The family history was irrelevant.

Twenty-six years ago the patient was employed on the construction of a pier of the Hell Gate bridge, working under air pressure of fifty pounds. He developed a typical case of caisson disease after being decompressed for the short period of five minutes. He was not recompressed. Symptoms were cramp-like pains in the abdomen and legs, nausea and vomiting, and bleeding from the ears and mouth. These disappeared after three weeks. He did not return to work under increased pressure. One year later he first noticed stiffness and pain in the right hip. This disability persisted and increased to such an extent that he had been unable to put on his right shoe for ten years. However, he was able to, and did continue his work as a carpenter until his admission to

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Bellevue, August 11, 1939. On that date he was struck by an auto and sustained contusions of the entire right side of the body, and minor fractures of the right foot and right hand. He was treated elsewhere in the Hospital for these injuries, and for acute alcoholism prior to his transfer to the Orthopaedic Service for treatment of his "arthritic" hip.

Physical examination showed the patient to be a well-developed and well-nourished man, confined to bed, and unable to walk because of pain in the right hip. Regional examination, except for the hip, was negative. His hearing was unimpaired.

The laboratory findings were as follows:

Urinalysis—specific gravity 1.021, negative
Red blood cells—5,100,000
Hemoglobin—90 per cent.
White blood cells—8,190
Polymorphonuclear neutrophiles—68 per cent.
Lymphocytes— 32 per cent.
Blood Wassermann—negative
Sugar—90 milligrams
Calcium—10.3 milligrams
Phosphorus—2.0 milligrams
Phosphatase—7.9 milligrams
Non-protein nitrogen—33 milligrams
Urea—21 milligrams

The right hip rested in slight abduction, flexion, and external rotation. There was slight atrophy of the thigh and leg. Motions of the hip were markedly restricted. Flexion of 5 degrees and abduction of 5 degrees were the only motions obtainable. The measurements of the lower extremities were R. U. 37½ inches; L. U. 36½ inches; R. A. 33 inches; L. A. 33 inches (apparent lengthening, one inch; actual lengthening, none).

Roentgenograms of the entire skeletal system were made, and are the important factor in the diagnosis of this case. Those of the right hip revealed an irregularly flattened femoral head, throughout which there are numerous areas of decreased density surrounded by bone of increased density, lacking in fine bone detail. There was some irregularity of the acetabulum corresponding to that of the head, and moderate narrowing of the joint space, with marked hypertrophic marginal changes of both the head and acetabulum. The diaphysis of the lower right femur revealed an irregular area, four inches in length, of unevenly increased density, which was quite sharply demarcated distally and faded off proximally. It did not extend within the epiphysis, or involve the cortex. There was a similar shadow of increased density in the diaphysis of the upper right tibia. It, too, was demarcated on its epiphyseal boundary and faded off toward the central part of the shaft. Again there was no involvement of the cortex. There is a well-healed fracture at the level of the lower and middle thirds of the right tibia.

Within the medullae of the proximal phalanges of the right second, third, and fourth fingers there were several tiny areas of irregularly increased density, and also a suggestion of irregular areas of decreased density in the cancellous bone. No other bones were involved. All flat bones were negative.

Operative Procedure

On October 2, 1939, the right hip was arthrodesed through an anterolateral incision. A Ghormley type of intra-articular fusion, which afforded the removal of a substantial section of the femoral head, was done. The exposed joint showed the characteristic changes found in osteo-arthritis,—thickened capsule, injected synovia, thinned and eroded articular cartilages, and marked hypertrophic marginal changes.

A portion of bone was removed from the front of the right tibia three inches below the knee joint. The cortex and underlying cancellous bone were removed, but no debris was noted, probably because the section was not removed deeply enough.

The patient was placed in a hip spica, and his postoperative course was uneventful, except for a rise in temperature on the thirty-eighth day which persisted for ten days.

FIG. 1

FIG. 2

Fig. 1: Anteroposterior view of right lower femur and upper tibia.
Fig. 2: Lateral view of right lower femur and upper tibia. (Defect in cortex inferior to tibial tubercle is site of biopsy.)

This was ascribed to a pneumonia of unknown type, the plaster making adequate chest examination impossible.

Microscopic examination of bone removed from the femoral head revealed scattered areas of increased density. No areas of debris were found. In the section from the upper tibia the cortex and immediately underlying cancellous bone were normal. Toward the medulla some calcified material was found as well as areas of necrotic bone. No gross debris was found. Figure 5 is a photomicrograph of a section from this biopsy.

There can be no doubt that the lesions of the right femoral head and lower shaft, and right upper tibia are on a nitrogen-embolism basis. The only trauma that the patient sustained was a fractured tibia, and that occurred two years after the onset of symptoms in the hip. The likelihood of fat embolism can hence be ruled out. It is likely that the so-called fractured hip twenty-three years ago was the collapse of the necrotic head mistakenly diagnosed as a fracture.

FIG. 4
Postoperative anteroposterior view of the hip showing bone graft.

FIG. 3
Preoperative anteroposterior view of the hip.

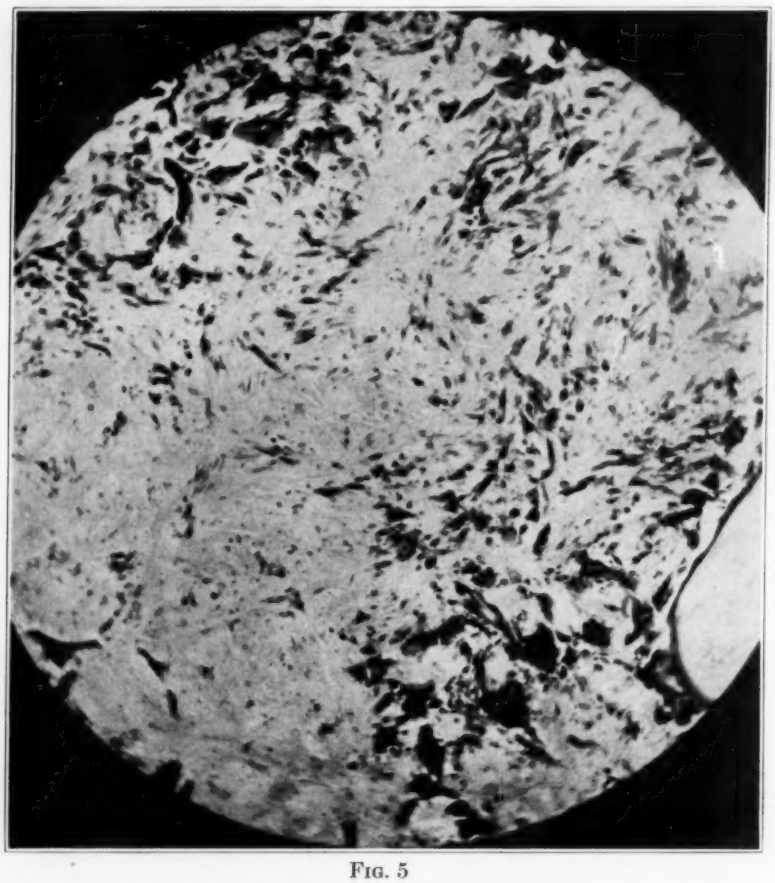

FIG. 5

Photomicrograph (low power) of biopsy specimen removed from the upper tibial lesion.

At the extreme right there is a necrotic spicule of bone with empty lacunar spaces and walled off by a thin rim of calcium. Scattered fragments of necrotic calcified bone are present throughout, visible as dark-staining masses; also some osteoblastic proliferation which probably walls off the massive infarct.

The character and distribution of the changes noted by the roentgenographic and biopsic findings in this case are practically identical with those of Phemister's cases. The irregular areas of increased density in the lower femur and upper tibia represent the calcified and ossified encapsulating wall surrounding debris of necrotic bone. The femoral head is flattened as a result of weight-bearing while necrotic. Its mottled appearance is due to irregular invasion of new bone and calcification of non-substituted areas.

The author wishes to acknowledge the assistance of Dr. Frank Nobiletti, Resident Surgeon at Bellevue Hospital, and of Dr. D. A. DeSanto, Pathologist at the Hospital for Ruptured and Crippled.

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AN ACTIVE THREE-POINT-PRESSURE SCOLIOSIS BRACE

BY THOMAS HORWITZ, M.D., PHILADELPHIA, PENNSYLVANIA

This brace is suggested for the ambulatory treatment of lateral curvatures of the spine which are primary in the midthoracic, lower thoracic, and thoracolumbar regions, and which are completely or partially flexible. The essential feature of its mechanism is the associated action of the components of an active three-point-pressure unit. This principle has been employed in several previously reported scoliosis braces. It was designed originally by an ingenious braceman, and, following clinical trial during the past four years, has been modified by the author.

The brace selected for description has been designed for a right

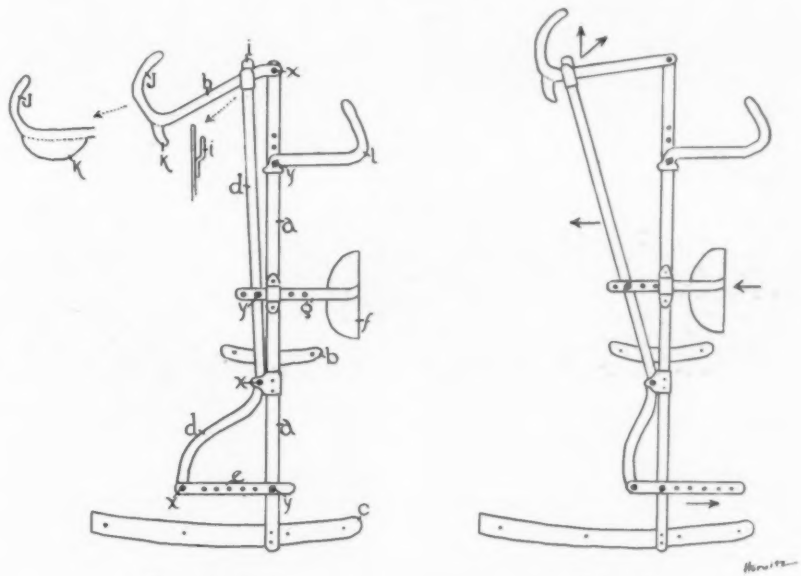

FIG. 1-A FIG. 1-B

Diagrammatic representation of the brace before (Fig. 1-A), and after (Fig. 1-B) its corrective forces are mobilized. The details of construction are referred to in the text.

thoracolumbar scoliosis (Figs. 1-A, 1-B, 2, and 3). The mechanism would be reversed for a left lateral curvature of the spine in the same region. It is constructed best on a plaster model made with the patient standing and the pelvis leveled. As much correction as possible is obtained by head traction and by three-point pressure against the lateral curvature. The front-lace celluloid base, molded over the iliac crests, grips the pelvis and buttocks snugly. All metal employed is surgical steel, except the soft iron tips which are used for the axillary crutches. Bar *a* (11/16 by 5/32 inch) lies just to the right of the midline and is attached to the celluloid

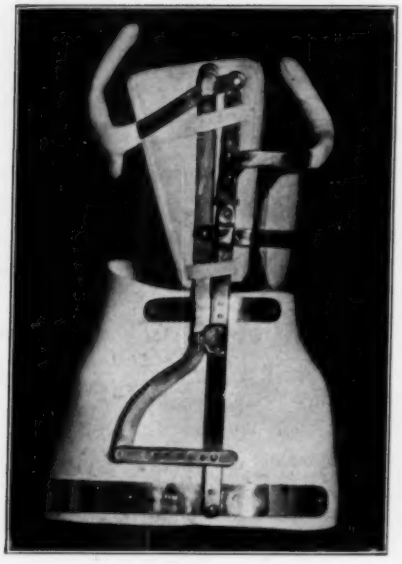

FIG. 2

FIG. 3

Fig. 2: The completed brace, constructed for a case with a partially flexible right thoracolumbar scoliosis.

Fig. 3: Brace applied to a fifteen-year-old girl with a severe right thoracolumbar and left lumbar scoliosis associated with a spina bifida occulta involving four or five midthoracic vertebral segments. Some correction has already been obtained by proper construction of the plaster model, prior to active use of the three-point-pressure unit.

FIG. 4-A

FIG. 4-B

base by bands *b* (1 by ⅛ inch) and *c* (1¼ by ⅛ inches). The latter, *c*, extends just beyond the anterosuperior spine of the pelvis on the side opposite the convexity of the scoliosis to permit the attachment of a thigh piece when this is necessary. Free joints are present at *x*, and there are simple screw fixations at *y* to allow for adjustments. As the lower lever of the movable V-shaped rod *d* (11/16 by ⅛ inch) approaches the fixed bar *a* through the adjustable bar *e* (11/16 by ⅛ inch), the upper and longer lever of *d* moves in an opposite direction. The efficiency of the short, lower lever is increased by the greater angulation between this arm and bar *a*. Movement of the upper lever of *d* away from the midline causes the large galvanized metal pad *f*, which is molded accurately over the apex of the scoliosis, to move towards the midline, as adjustable bar *g* (11/16 by ⅛ inch) passes through a guide. At the same time it forces the curved bar *h* (11/16 by ⅛ inch) upwards as it glides within the guide *i* at the upper end of bar *d*. The axillary crutch *j* and the small galvanized metal pad *k* are so constructed as to exert pressure against the upper torso and to elevate the left shoulder. The axillary crutch *l* serves to hold the opposite shoulder backwards. The parts of the brace contacting the skin are covered with soft leather and are padded with white felt or lined with molecloth.

FIG. 4-C

Right thoracolumbar scoliosis (idiopathic), with transposition of the upper trunk to the right, in a thirteen-year-old girl. Anteroposterior roentgenographic views show condition before application (Fig. 4-A); after application of the unopened brace (Fig. 4-B); and one year after the use of the active three-point-pressure unit. A celluloid jacket has been applied to maintain the correction of approximately 25 degrees in the primary lateral curve.

Adjustment of bar *e* causes increased pressure against the apex of the primary lateral curve and contralateral pressure against the torso and beneath the opposite axilla. By adjusting bar *g*, these two forces may be activated independently. With the pelvis fixed within the celluloid base, the effect will be not only to diminish the scoliosis, but also to correct an ipsilateral transposition of the trunk, although when the latter deformity is severe it may be necessary to attach a thigh piece. Maladjustments as a result of growth are corrected by adjusting the length of bars *a* and *d* (these bars may be made excessively long initially or segments may be added), and by elevating the positions of bars *g* and *h*, guide *i*, and axillary crutch *l*.

A METHOD FOR MAINTAINING THE CUT EDGES OF SPLIT AND BIVALVED CASTS IN ACCURATE APPOSITION

BY R. CLAYTON ROUNDS, M.D., DENVER, COLORADO

From the Children's Hospital, Denver

Adhesive tape or cloth straps are commonly used to maintain in apposition the cut edges of bivalved and split casts. However, where it is necessary to remove the cast frequently to exercise or massage the immobilized part, adhesive closure becomes a messy, expensive procedure. Cloth straps, although inexpensively and rapidly applied, frequently fail to maintain the sections in good approximation and produce overlapping or telescoping of the cut edges. The following method eliminates adhesive and cloth strapping, and maintains the cut edges of the cast in accurate apposition.

TECHNIQUE

Two plaster splints, four by fifteen inches, are folded longitudinally along the midline over a webbing or canvas strip three-fourths inches wide, as shown in Figure 1. Holes are then punched at two-inch intervals along the folded border about one-half inch from the edge. Through the punched openings nickel-plated boot hooks are inserted and cinched in place. When needed, the

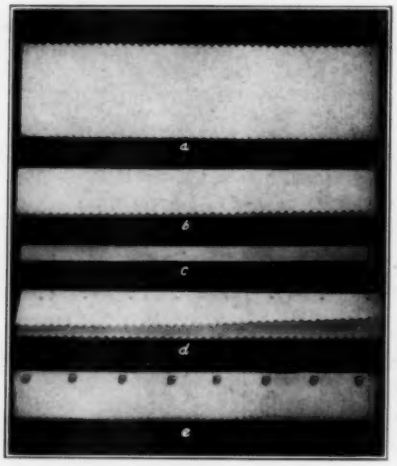

FIG. 1

Photograph illustrating method of preparing boot-hook strips.
a: Hard-coated, rapid-drying plaster splints.
b: Splints folded longitudinally.
c: Webbing reinforcement.
d: Webbing inserted and holes punched to receive boot hooks.
e: Finished strip.

FIG. 2

Plaster body jacket split and laced.

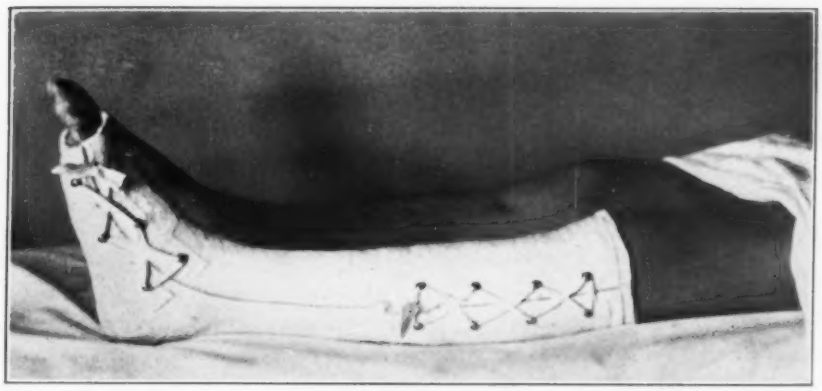

FIG. 3

Bivalved leg cast with anterior and posterior shells laced together.

entire strip or as much as desired is dipped in water and applied to the moistened and roughened cast and rubbed well to eliminate all air bubbles and insure permanent union of the hook strip to the cast. A second strip, having the same number of hooks, is applied in a similar manner to the other section of the cast with the hooks opposite each other. The plaster is then allowed to dry thoroughly, preferably for twenty-four to forty-eight hours before the lacings are applied.

COMMENT

Although the hooks may be applied to any type of cast desired, the method has been used to best advantage in the apposition of the edges of split casts (Figs. 2 and 3) and, in particular, split body jackets. It has also been very useful in fixing and maintaining the position of bivalved arm or leg night shells in young and active children. It is important that the plaster be perfectly dry before the lacing is applied, for if applied too early there is a tendency for the plaster to crack about the hooks, and loosening may occur.

At the Children's Hospital, where this method has been in use for about ten months, the boot-hook strips are prepared by the older patients in the Department of Occupational Therapy, and a supply is kept on hand in the plaster room to be available when needed.

ACCESSORIES FOR WEDGING PLASTER JACKET IN THE TREATMENT OF SCOLIOSIS

BY C. W. GOFF, M.D., AND J. H. ALDES, M.D., HARTFORD, CONNECTICUT

From the Newington Home for Crippled Children, Newington, Connecticut

Pragmatism should govern the orthopaedic surgeon in his treatment of scoliosis, a costly deformity both to the patient and the surgeon. To cut down this burdensome process to a minimum, the following steps have been developed over a four-year period, during which the turnbuckle and wedging plaster jacket, as described by Smith, Butte, and Ferguson[1] has been used in the corrective treatment of scoliosis. No attempt will be made

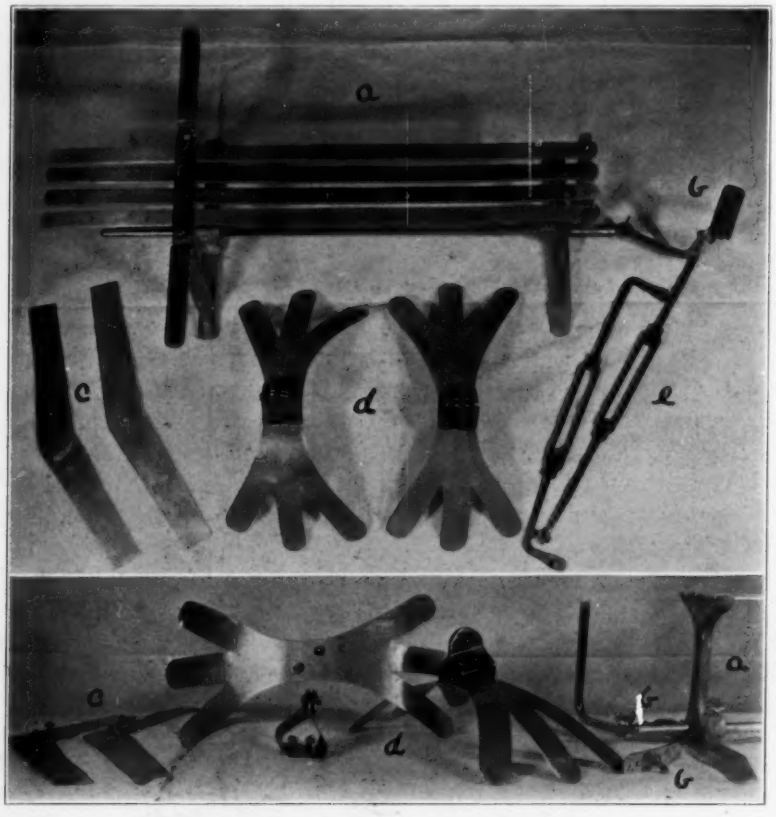

FIG. 1

Hardware modifications. *a:* Goldthwait frame with head support. *b:* Demonstrates use of frame to steady head during incorporation of patient in plaster jacket. *c:* Duralumin hinges drilled to take two-inch stove bolts. *d:* Removable holders. Note how the parts are separated; flanged portion is incorporated in plaster and turnbuckle attachments bolted on when plaster is cut, after three to five days' drying. *e:* Turnbuckles, ends bent and drilled for bolts.

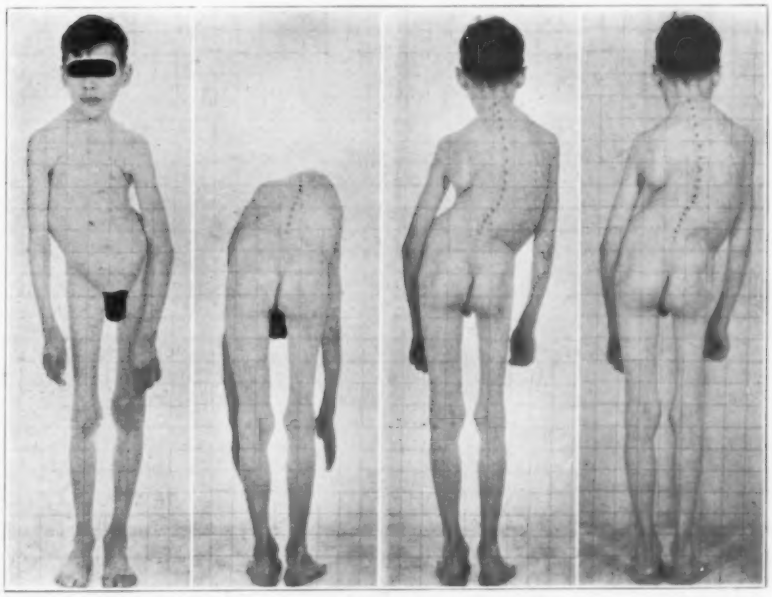

FIG. 2-A
Posture pictures before treatment.

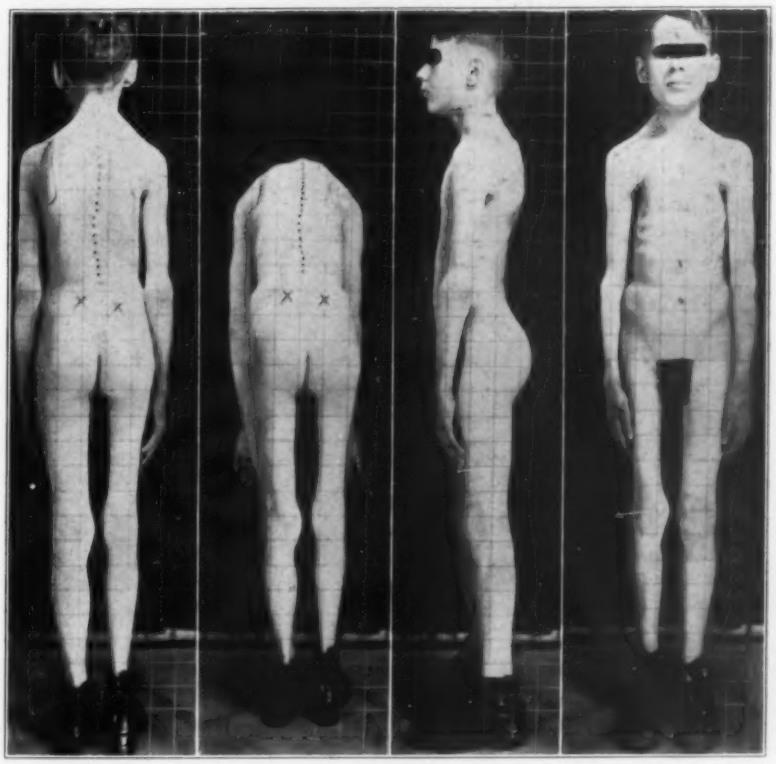

FIG. 2-B
Posture pictures after treatment.

to quote the voluminous literature or to go into the theory of treatment. This is a personal report of practical points found useful and effective.

Posture pictures are taken before treatment is begun, and, again,

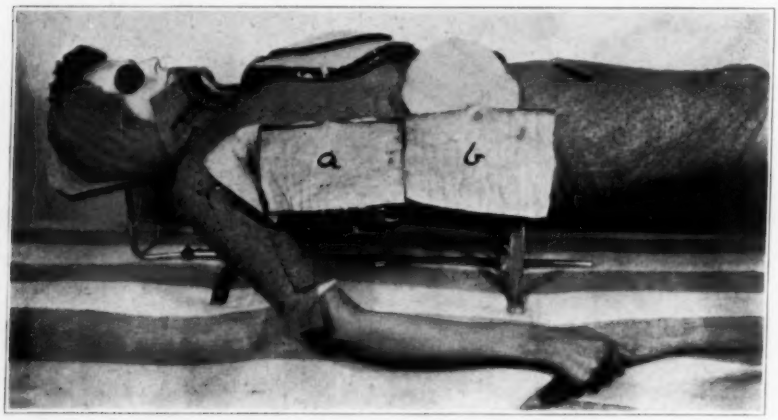

FIG. 3

First jacket is applied over felt garment as shown. Extra heavy felt pads are placed over bony prominences and beneath hinges, as well as two oblong pads on the side away from the turnbuckle. These pads (*a* and *b*) are removed when plaster is wedged and before correction is begun. Note longitudinal felt strip under chin and pad under occiput. Goldthwait frame with modification is used to support head during application of jacket.

FIG. 4

FIG. 5

Fig. 4: Completed plaster jacket is painted with white duco and the margins are neatly taped. Correction is progressing with comfort to the patient.

FIG. 5: Plaster has been cut away under the axilla and a special sling substituted which is attached to the front and back hinge bolts. Maintenance of correction is easily secured.

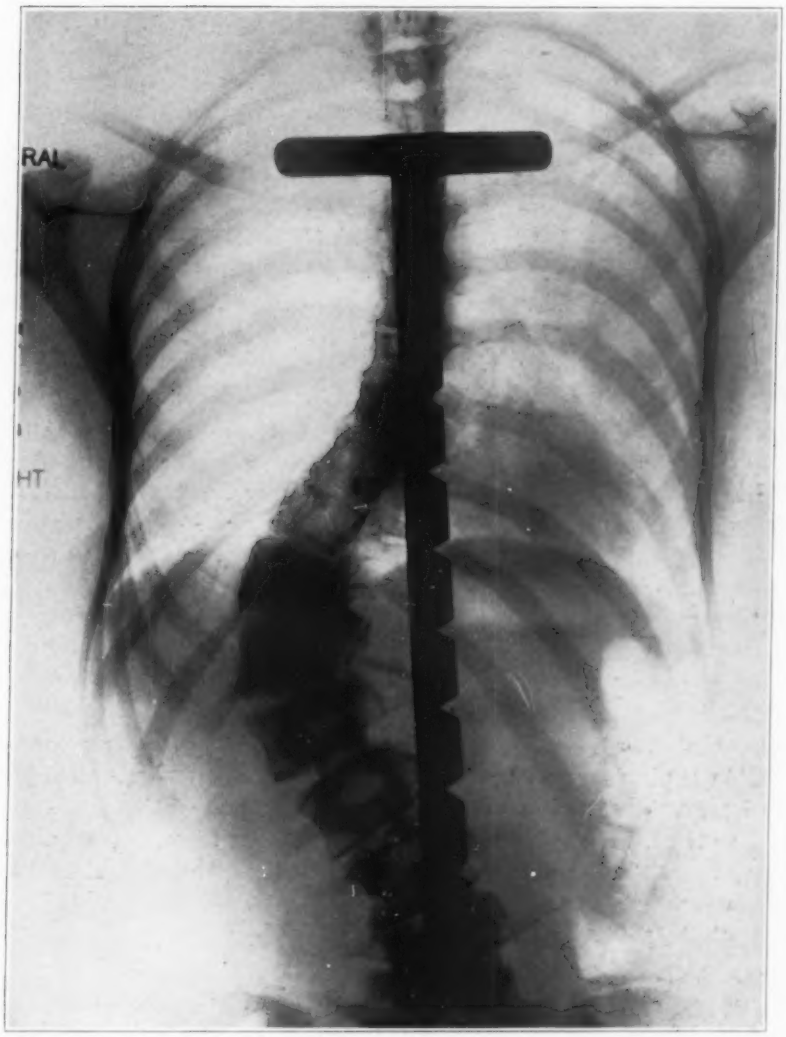

FIG. 6

Roentgenogram showing marker to locate apex of primary curve for placing hinges.

after it has been completed (Figs. 2-A and 2-B). These are taken through a thread screen.

Roentgenographic studies are made with the patient standing in several positions, or sitting with a two-inch block under alternately the left and right buttocks, to determine the location, extent and correctibility of the primary curve at onset of treatment, and to show the strength of fused area after treatment has been completed.

Hardware modifications that have proved their worth consist of duralumin hinges with two-inch stove bolts, incorporated in plaster, on each side of rivet. The nuts are tightened to fix the hinge securely to the

jacket walls. Such a hinge does not pull out under corrective leverage. The attachments for the turnbuckle are in two parts which are bolted together as illustrated with the flanged portion embedded in plaster, and the protruding piece bolted on later for security. Turnbuckles are bent at their ends and drilled to take a small bolt.

The Goldthwait frame is modified to include an extension which will hold the head, during the application of the jacket, toward the side on which the turnbuckle is to be placed (Fig. 1).

A thin felt garment is cut and fitted to patient over cotton stockinette, and is padded over all prominent parts, especially beneath both hinges and on the side away from the turnbuckle. These last two pads are removed when plaster is cut, and before correction is begun. This additional space allows the thorax to push into that side and helps correct the gibbosity. A strip of felt placed longitudinally under the chin gives great comfort to the patient (Fig. 3).

Including the thigh in plaster on the side of the turnbuckle has reduced pressure sores to a minimum, and has appeared to be more efficient than including the opposite thigh. Thus the pelvis is fixed where leverage and pull are greatest. After cutting and trimming, jackets are taped about the margins. This is followed by a coat or two of white duco paint to preserve the plaster (Fig. 4).

Plaster against the thorax beneath the axilla on the side opposite the turnbuckle gave rise to many complaints until a sling was substituted toward the latter half of the correction period. The sling is made of substantial webbing covered with felt and stockinette, attached to the jacket with leather tabs, and buckled in front. The ends of the sling are fastened to the bolts of the upper arm of the hinges through a grommet in leather tabs. This sling has proved its worth beyond that of any other modification improvised (Fig. 5).

FIG. 7

Jacket is fenestrated to expose area for fusion. In this illustration, patient has had the first stage of fusion of five dorsal vertebrae and is awaiting the second stage of fusion. Turnbuckle is left in place for additional support.

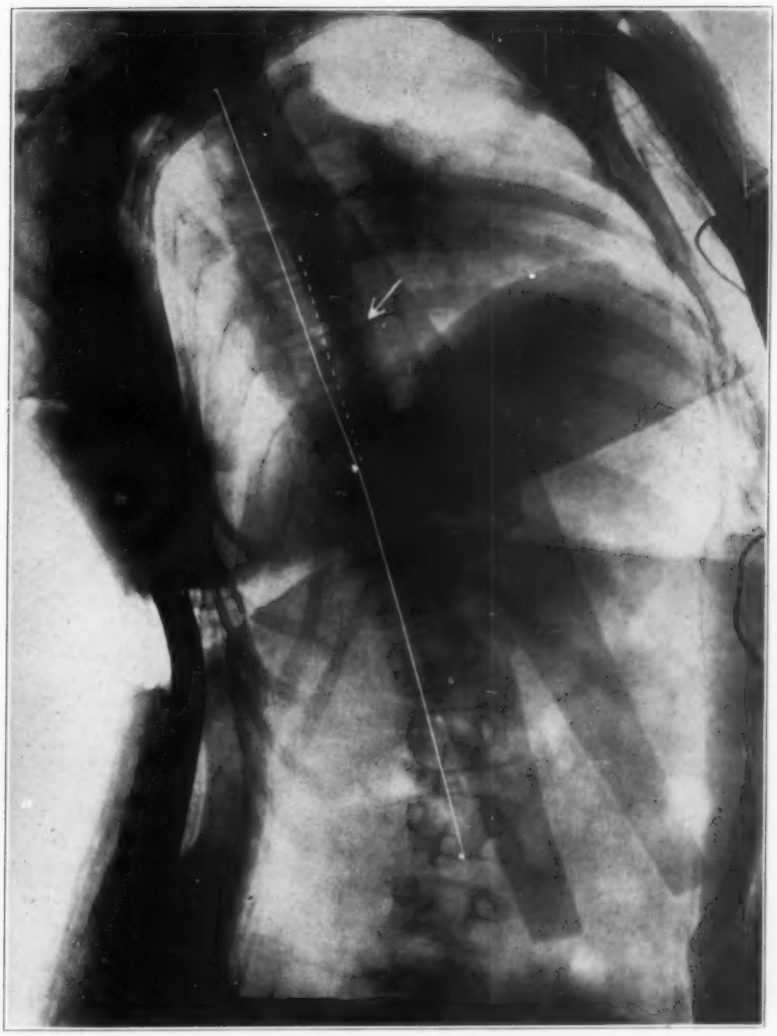

FIG. 8

Roentgenogram showing iron side bars, fenestrated jacket, and hypodermic needle with a portion cut off (at arrow) in eighth dorsal vertebral spinous process. This permits easy identification of vertebrae at time of fusion.

The hinges should be placed just off midline and directly over the apex of the curve to be corrected. This was most difficult to accomplish with accuracy. To aid in placing the hinges, a strip of steel, notched at inch intervals, was placed at the tip of the chin over the anterior chest wall extending toward the xiphoid. A roentgenographic plate was exposed for an anteroposterior view, and the point of the apex of the curve was easily determined. This same strip then is used to locate hinges at the time of application of the jacket (Fig. 6).

The back of the jacket is cut out between strips of soft strap iron

which have been bent and incorporated in the plaster to reinforce the sides. Fenestration of the back of the jacket permits easy access for operative fusion (Fig. 7). A No. 22 hypodermic needle is driven through the cleansed, anaesthetized skin of the back, into the spinous process of a vertebra near the apex of the primary curve. This affords a ready identification of the vertebrae at time of fusion (Fig. 8).

The first jacket, applied the third month after fusion, is of plaster, as may well be the second jacket. The first jacket has supports over both shoulders and is applied on the Goldthwait frame. The second jacket is applied erect with head traction. The final jacket is of celluloid, and is worn for one year. This is made of six layers of stockinette or eight layers of crinoline, with two coats of celluloid between layers. Hooks are sewed up the front, and the jacket can be removed for bathing, etc.

The average patient in the first series of twelve cases was hospitalized for fifty-five weeks at a cost of $1050. The next twelve averaged sixty-two weeks in hospital at $1200 and the third series fifty weeks at $950. Time for correction has been cut down gradually, and, as we approach our fiftieth case, we can anticipate a hospitalization of forty-six weeks at a cost of $870, which is within reason. This does not include cost of precorrection treatment, or treatment rendered after the child has been discharged from the hospital.

1. Smith, A. DeF.; Butte, F. L.; and Ferguson, A. B.: Treatment of Scoliosis by the Wedging Jacket and Spine Fusion. J. Bone and Joint Surg., XX, 825, 1938.

NEW ISCHIAL SEAT BRACE FOR ELIMINATION OF WEIGHT-BEARING

BY HENRY H. JORDAN, M.D., NEW YORK, N. Y.

More than half a century ago E. G. Brackett improved the Dowse splint for the lower extremity by using a "perineal band", consisting of three adjustable leather straps, for transmission of weight from the pelvis to the ground. This successful construction was recently rediscovered by H. v. Baeyer who, in 1937, described the following modification of the same principle. The new *leather-strap* ischial seat has considerable advantages for both the patient and the bracemaker, and is, therefore, recommended for general use in a wider variety of conditions calling for the elimination of weight-bearing.

The leather-strap seat transfers the body weight from the tuber

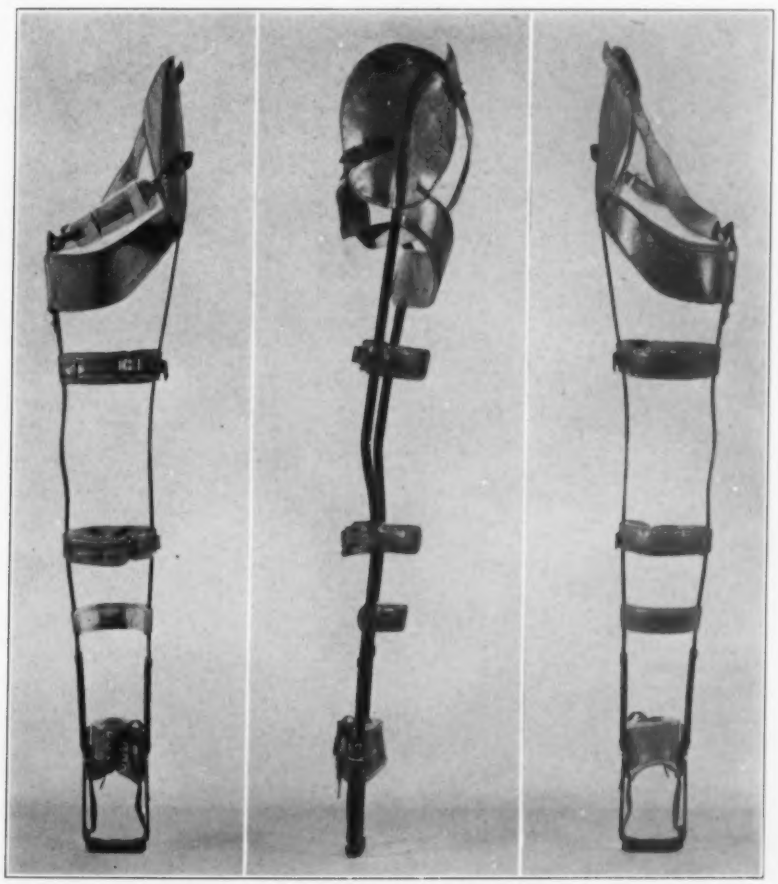

FIG. 1

ischii and the lower ramus of the ischium to the *lateral* upright longitudinal bar of a double-bar leg brace; thus the construction differs in two important points from the other known "unweighting" braces. First, a soft leather strap replaces the rigid, and necessarily more bulky, ischial seat of the Thomas ring, or the Hessing brace, or the Galland type of construction. On standing and walking, the tuber ischii rests securely in the leather loop which naturally conforms to the shape of the body and causes no irritation at the perineum. This is still more important for the sitting position which, with any one of the rigid seat constructions, means considerable discomfort. Moreover, the introduction of a leather strap as a weight-transmitting seat makes the building of this type of brace much easier.

The second feature wherein the leather-strap seat brace differs from other constructions is the suspension of the weight at the proximal end of the *external* longitudinal bar at a level above the trochanter. This calls for great strength of just one bar, while the other elements of the brace

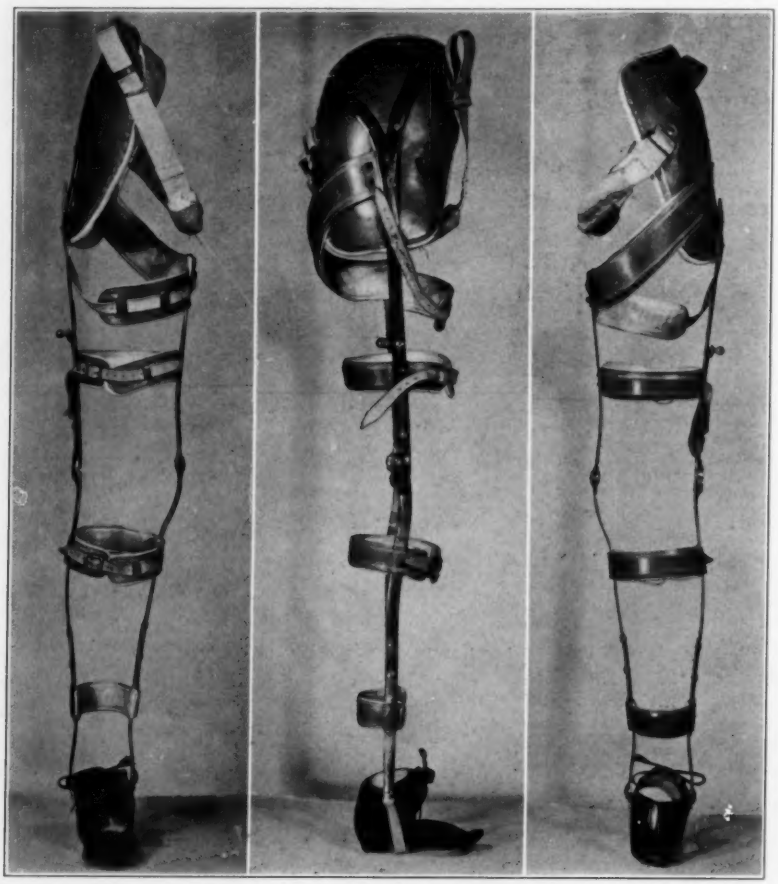

FIG. 2

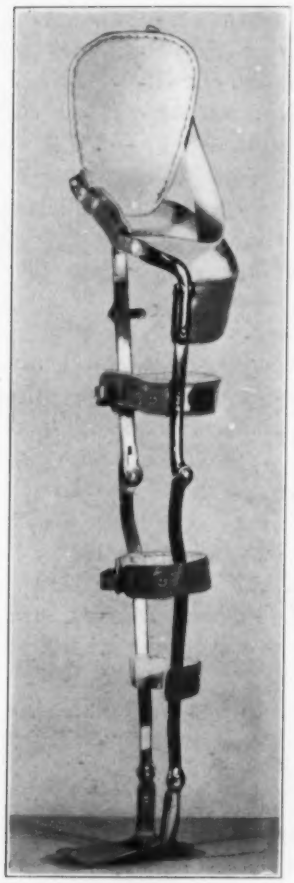

FIG. 3

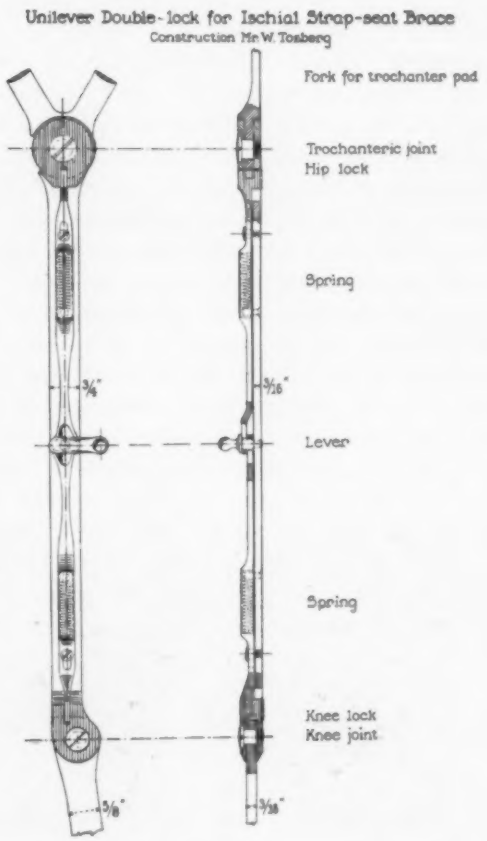

FIG. 4

may be rather light. The medial upright ends far below the perineum, and the proximal semicircular band connecting the two uprights may run far below the gluteal fold. The support of the body weight by the seat strap introduces a force which tends to keep the brace the closer to the body, especially in the region of the trochanter, the more weight is placed on the seat. This makes auxiliary forces, such as a pelvic band, superfluous.

The leather-strap seat lends itself to practically every type of brace construction one might select for the needs of the individual patient. In its most primitive form the ischial strap-seat brace may be built as a jointless brace with a patten (Fig. 1). The ischial strap seat may be incorporated into any double-bar leg brace with ankle joint and stirrup or sandal, provided there is a lock at the knee joint (Fig. 2).

Pressure of the strap on the adductor muscles can be avoided by adding to the proximal end of the medial upright a rectangular bar. One end of the leather strap is riveted to its horizontal arm (Fig. 3).

After the patient has worn the brace for some time, it is possible to trim the trochanteric pad as much as two inches without losing its "unweighting" effect. Where skilled labor is available, and the expense is of minor importance, the brace may be built with a *trochanteric lock joint.* For this purpose a unilever double lock was designed by W. Tosberg, which is a modification of the joint known in the literature as the O. I. (*Orthopaedische Industrie*) knee lock joint. The small lever which operates the knee lock simultaneously operates the lock for the trochanteric joint, and on sitting down the hip and the knee joint may be flexed in a normal manner (Fig. 4).

The development of the ischial strap-seat brace into an appliance which is inexpensive, easy to manufacture—if necessary within one day—and guarantees an efficient "unweighting" of the lower extremity without the usual discomfort to the patient, has widened the field for its use. The simplest form of the strap-seat brace has proved extremely satisfactory in a series of cases of slipped femoral epiphysis, especially when applied in the so-called preslipping stage, and in Perthes' disease. The more elaborate double-bar leg brace with the strap seat and lock joints has been successfully used in the treatment of patients with arthritis of the hip joint, chiefly the unilateral malum coxae senilis. Another group, for which this brace may be recommended, are the aged patients with fracture of the neck of the femur.

The ischial strap-seat brace is equally useful when the lesion requiring treatment is at the knee or foot section of the leg.

SUMMARY

An ischial seat brace for "unweighting" the lower extremity introduces a leather-strap seat. The new construction principle simplifies the manufacture and fitting of an ischial seat brace, eliminates various known causes of discomfort to the patient, and thus widens the field for the use of an ambulatory orthopaedic appliance.

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A GUIDE FOR DRILLING UNUNITED FRACTURES

BY PETER G. SHIFRIN, M.D., DETROIT, MICHIGAN

The operation of drilling multiple drill holes across a fracture line for delayed healing or non-union has met with sufficient success to remain as a permanent procedure in the armamentarium of the surgeon. However a few technical details have always been a source of annoyance in carrying out this procedure. One is that unless the puncture incision is made large enough, the drill, especially a motor drill, injures the skin edges. If the incision is large enough, say one-half to three-fourths inch, retraction by an assistant with small retractors is clumsy, particularly if direct fluoroscopic observation is undertaken at the time the drill is trav-

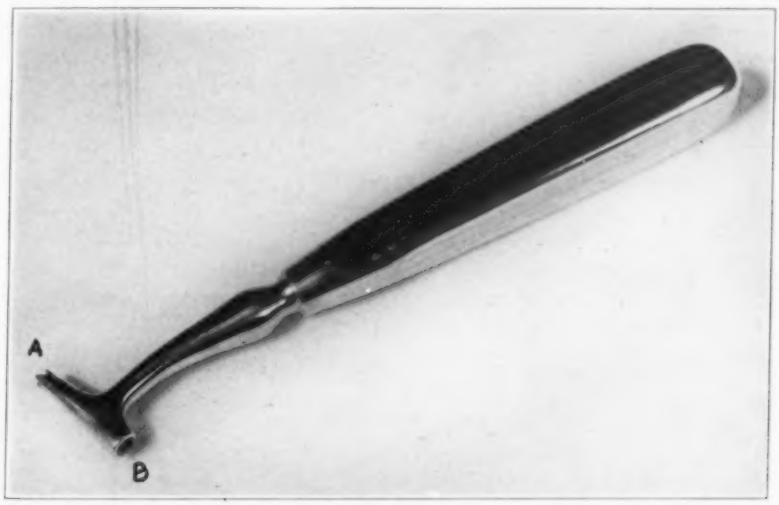

FIG. 1

ersing the fracture line. Another point of difficulty encountered is, after one or two divergent holes are made from one starting point, it is hard to start more diverging channels from the same point, since the drill tends to slide into the previously made channels.

The instrument here presented (Fig. 1) overcomes these difficulties with remarkable success. It consists of a tempered steel tube of one or one and one-half inches in length, and one-fourth inch in diameter on the outside, which will admit with slight play a three-thirty-seconds-inch drill bit. The upper end (*B*) of the tube is slightly beveled on the inside; the lower end (*A*) consists of three sharp prongs, beveled from the inside.

Its use is simple. After infiltrating with local anaesthetic a small area above and below the line of fracture, down to the periosteum, quarter-inch stab incisions are made. End *A* of the instrument is inserted

through the wound to the bone surface. With the instrument held at whatever angle of inclination is desired, a firm tap with a mallet over end *B* will engage the prongs. The direction may now be checked under a fluoroscope. The instrument is held with the left hand, while the right hand operates the electric drill; or the instrument is supported by an assistant if a hand drill is used. The guide is now disengaged, the direction changed, and the procedure repeated.

Ordinarily the one-inch tube is sufficiently long to reach through the soft tissues to the bone; however, on femora, and in other locations on very muscular or fat individuals, the one-and-one-half-inch tube will be required.

SELF-ILLUMINATING PATELLA RETRACTOR

BY MILTON C. COBEY, M.D., WASHINGTON, D. C.

An excellent view of the knee joint, as well as its illumination throughout, is obtained by the use of a knee retractor, made from lucite and modeled from a steel patella retractor originally designed by George E. Bennett, M.D., Professor of Orthopaedic Surgery, Johns Hopkins Hospital.

The retractor is so constructed that it easily slides under the articular surface of the patella, and conforms to this surface in such a manner that it does no harm. In this position the retractor holds the patella upwards and laterally or medially as desired, thus adequately exposing the articulating surfaces of the knee joint and of the quadriceps pouch.

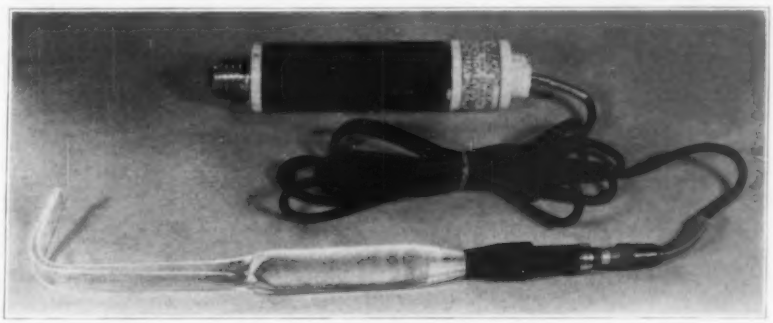

FIG. 1

Lucite allows the passage of light throughout its entire length. Forty per cent. of the light is given off at the elbow, and 60 per cent. at the end of the retractor. The cord, bulb, and adaptor of the light outfit are boilable. However, as lucite softens and cracks after several boilings, the retractor is rendered aseptic best by cold sterilization. Bacterial studies have shown that cold sterilization is satisfactory and quite safe. The material is not easily broken, and has an added advantage over glass,—under strain it will bend before it breaks. However, under normal use in an operation upon the knee, there is no excuse for the retractor to bend.

This illumination of both the medial and lateral surfaces of the joint from the incision affords a clear visual examination of the articular surfaces and quadriceps pouch. It is particularly useful in exploring a joint for loose bodies, foreign bodies, and the cartilaginous plaques of osteochondritis dissecans. It is also most valuable in synovectomies through the utility type of incision, particularly in making visible the synovial membrane on the far side of the wound.

ALBERT H. FREIBERG

1868–1940

Dr. Albert H. Freiberg died in Cincinnati, July 14, 1940, after an illness of two weeks. He was born in Cincinnati, August 17, 1868, the son of Joseph and Amalia Freiberg. He is survived by his wife, who was Jeannette Freiberg, and two sons, Joseph A., who was associated with him in his practice, and Albert M., who is an attorney.

He was a graduate of the University of Cincinnati and of the Medical College of Ohio, which later became the Medical College of the University. After his internship at the General Hospital he spent considerable time abroad, studying at the universities of Würzburg, Strasbourg, Berlin, and Vienna. On his return to this country in 1893 he began practice in Cincinnati, and, as was the custom in those days, he began with general work, but his aim always led him toward specializing in orthopaedic surgery.

Dr. Freiberg always took an active part in the affairs of his profession and was a member of the American Medical Association, the American Orthopaedic Association, the Clinical Orthopaedic Society, and a Fellow of the American College of Surgeons and of the American Academy of Orthopaedic Surgeons. He was also active in local medical affairs. He was President of the Ohio Medical Society, 1929–1930; the Cincinnati Academy of Medicine, 1923–1924; and Chairman of the Orthopaedic Section of the American Medical Association, 1917–1918. Dr. Freiberg played an important part in the establishment of orthopaedic surgery in his city and state, and the present position of orthopaedic surgery in that community is largely due to his influence and the result of his work. He was Chief of the Orthopaedic Service at the Cincinnati General Hospital, at the Children's Hospital, and at the Jewish Hospital while in active practice, and continued to serve as consultant at these hospitals. At the time of his retirement from the Chair of Orthopaedic Surgery at the Medical College of the University two years ago, he was made Professor Emeritus. During the World War he served as Major in the Medical Corps, United States Army, and was Chief of the Department of Orthopaedic Surgery at Walter Reed Hospital at that time.

Dr. Freiberg always took a special interest in the affairs of the American Orthopaedic Association, particularly in its development, to the end that it might be an important and influential factor in establishing and maintaining a high and dignified standard. He was President of the Association for the year 1910–1911 and always took an active part in the scientific and administrative proceedings of all of its meetings, and served on many important committees. In the executive meetings Dr. Freiberg was frequently consulted on matters of parliamentary law. His mind was keen and analytical, his judgment fair and tinged with kindliness. He was a splendid speaker and his tongue had no barb. He was influential in debate and frequently turned the discussion toward a correct and wise decision. His honesty and good sense added weight to his opinions. He took a prominent part in its scientific sessions and the Association always looked forward to his communications as being of value for they indicated the result of his experience and excellent judgment. His position was always foremost in the advance line of progress.

He was an active contributor to medical literature. He showed a good deal of originality, and was always foremost in aiding advancements which came to orthopaedic surgery through the enlargement of the field of surgery resulting from the advent of antiseptic surgery. He kept in close touch with the departments of medicine other than that to which he devoted his life, and he did this on principle as part of his eager quest for knowledge, which was evident in his clear sense of values and breadth of grasp. His consideration of all sides of any problem gave weight and confidence to his decision.

He always gave much of his time and thought to the problem of rehabilitation of crippled children, and was one of the first members of the profession to advocate state aid for their care. He accomplished a great deal in interesting the community and also other states in the solution of this problem and in the establishment of legislation for state aid.

ALBERT H. FREIBERG

He was Chairman of the Advisory Committee on Crippled Children of the Children's Bureau, United States Department of Labor.

Dr. Freiberg was a man of broad interests, not wholly confined to medicine. He always took time to occupy himself with affairs outside of his profession, and had the courage to give himself opportunity for the expression of his love of music, in which he was proficient, and for many years he played weekly with his orchestra. He was also interested in education and art and was a member of many committees and societies. The finer influence of the arts was evident in the sum total which gave to him his distinctive qualities.

His contribution to the social gatherings of the Association was a prominent and expected feature. He will be greatly missed and will always be in our memory.

AUGUSTUS THORNDIKE

1863–1940

Dr. Augustus Thorndike died suddenly on August 23, 1940, at his summer home in Bar Harbor, Maine, at the age of seventy-seven years. His wife, the former Alice Amory of Boston, whom he married in 1892, died two years ago. They had five children, who survive him: Mrs. Lyneham Crocker, Mrs. Alexis Sommarina, Dr. Augustus Thorndike, Jr., Charles Thorndike, and Robert Amory Thorndike.

He had devoted the entire period of his medical career to orthopaedic surgery and contributed frequently to the orthopaedic literature. He was the author of "A Manual of Orthopedic Surgery" which was adopted for use in many medical schools.

Dr. Thorndike became a member of the American Orthopaedic Association in 1893, was in regular attandance at its meetings, and interested himself in its administration and scientific proceedings. He served as its President for the year 1909–1910, presiding at the Annual Meeting held in Washington, D. C., and continued to take an active interest in its affairs. The welcome accorded him at the Association meetings was evidence of the high esteem in which he was held by all the members.

He was born in Paris, but received his education in the community in which he always lived. He was a graduate of Harvard College in the Class of 1884, and of Harvard Medical School in the Class of 1888. After finishing his early medical education, he served as an Intern on the Surgical Service of the Massachusetts General Hospital, and later was Intern at the Boston Lying-In Hospital and at the House of the Good Samaritan.

After completing his preliminary training, he established himself in the practice of medicine in Boston, and from the first he occupied himself with the problems of orthopaedic surgery. During the time of his service at the House of the Good Samaritan he became interested in the special care necessary in the treatment of the crippled child. At that time a large proportion of the cases were tuberculous, and, because of the fact that hospital equipment was then meager, these children required a great deal of careful attention and personal supervision from those who were in surgical charge. From the beginning of his work in this Hospital, Dr. Thorndike showed his capacity for conscientious care and his sympathy for these children, which were demonstrated by the success which he had with these difficult and protracted cases. He was also visiting surgeon in the Orthopaedic Department of the Boston Dispensary and at St. Luke's Home for Convalescents to which he gave freely of his time and effort.

During the entire period of his active practice, Dr. Thorndike served as a member of the Staff of the Boston Children's Hospital. It was this institution to which he devoted the greatest amount of his time and energy. Such a service, at that time, to be performed faithfully, required devotion and sacrifice of personal interests, and his contribution to this Hospital was a very prominent feature. It was characterized by his unusual dependability and by his careful and painstaking attention, not only to the surgical care of the children but also to their general interest, and he was untiring in his efforts to bring the best to this group of children.

Dr. Thorndike was always especially interested in the problem of the crippled child, and occupied himself very largely with its solution,—not only as to medical and surgical care, but toward providing opportunities to offset the loss of those advantages of which they were so often deprived because of their infirmities. He was particularly interested also in the provision for their education and for manual training, to be given with the object of fitting them for some gainful occupation. He was one of the incorporators of the Boston Industrial School for Crippled Children and served as a member of its Board of Directors as well as of the medical Staff during the early period of its establishment, and he was influential in the conduct of its affairs in its later growth. He also took part

AUGUSTUS THORNDIKE

in the establishment of the State Hospital School for Children at Canton which was organized some few years after the incorporation of the School for Crippled Children.

He was a member of the American Medical Association, a Fellow of the American College of Surgeons, and also an active member of many societies in his community,—the Massachusetts Medical Society, the Society of Medical Sciences, and the Boston Medical Benevolent Society. He was also interested in the Boston Medical Library.

Dr. Thorndike's helpful attitude toward his associates, and particularly with his coworkers, was an outstanding feature of his character, and he gave freely of himself. He was just in his estimate of people, free from criticism, and tolerant toward the opinions of others. He was a good friend and had a philosophy of life that drew all to him.

News Notes

Word has been received of the death of Mr. R. C. Elmslie, of London. A more extended notice will be included in the next issue of *The Journal*.

The Annual Meeting of the **British Orthopaedic Association** will be held in Liverpool on October 25 and 26.

Dr. Austin T. Moore announces the opening of The Orthopedic Hospital and the Moore-Green Clinic at Gervais and Pickens Streets, Columbia, South Carolina.

The Annual Roll Call of the **American Red Cross** to enlist members for 1941 will be conducted throughout the nation from November 11 to 30, 1940.

The Annual Meeting of the **Orthopaedic Guild** will be held in New York City, November 1 and 2, under the chairmanship of Dr. Robert L. Preston.

The next examination of the **American Board of Orthopaedic Surgery** will be held at New Orleans in January 1941, just preceding the meeting of the American Academy of Orthopaedic Surgeons. Applications for this examination must be filed with the Secretary, Dr. Fremont A. Chandler, 6 North Michigan Avenue, Chicago, Illinois, on or before November 15, 1940.

The **Buckeye Orthopaedic Club** of Ohio was formed in Cincinnati on May 14. The Club plans a meeting each year at the time and place of the Ohio State Medical Society meeting, to consider matters of interest to orthopaedic surgeons of the State and to participate in a clinical day. Dr. Albert H. Freiberg was elected the first President, and upon his death in July he was succeeded by Dr. Bart G. Chollett. The Secretary of the Club is Dr. Edward Harlan Wilson of Columbus.

The Ninth Annual Convention of the **American Academy of Orthopaedic Surgeons** will be held in New Orleans, Louisiana, January 12 to 16, 1941, under the Presidency of Dr. Robert D. Schrock.

The first day will be devoted to committee meetings. Monday, January 13, will be a Clinical Day arranged by Dr. Guy A. Caldwell and his committee. The program for Tuesday, January 14, includes a discussion of new procedures in orthopaedic treatment at the morning session, and, in the afternoon, papers on bone tumors. On Wednesday morning the papers will deal with the progress in orthopaedic surgery, and the afternoon will be devoted to the consideration of fractures. The scientific program will continue until Thursday noon when the second executive session will be held.

Guest speakers at the Meeting will include Dr. Murray Copeland who will speak on "The Classification of Bone Tumors", and Dr. Alton Ochsner whose subject will be "Thrombophlebitis".

A complete program of the Meeting will appear in the January issue of *The Journal*.

Current Literature

PRINCIPLES OF SURGICAL CARE. SHOCK, AND OTHER PROBLEMS. Alfred Blalock, M.D. St. Louis, The C. V. Mosby Company, 1940. $4.50.

The regulation of circulation, including blood pressure and cardiac output, has for nearly fifteen years been subjected to critical study, both in the laboratory and in the hospital, by Dr. Blalock and his associates. Out of these studies has been evolved a most complete theory, supported by accumulated data, by which surgical shock might be explained, prevented, or successfully treated.

The results of these studies are reported in this very interesting and instructive monograph of 308 pages. In this monograph Dr. Blalock has discussed anaesthesia, surgical technique, the circulatory system, shock, and fluid and electrolyte balance. In the latter chapters Dr. Blalock has included a review of nutritional disorders, diabetes, hypertension and nephritis, endocrine disorders, and pulmonary or abdominal post-operative complications.

The physician who devotes any considerable portion of his time to surgery, owes it to himself and to all of his future patients, to provide himself with the knowledge, or at least the source book of knowledge, which will make him more alert to detect, prevent, or treat any or all of the multitudinous complications which may follow an operation. For those who wish to so fortify themselves, this book is specifically recommended.

SURGERY OF THE HAND. WOUNDS, INFECTIONS AND CLOSED TRAUMATA. A Book for the Practitioner and the Surgeon. Marc Iselin, M.D. Translated by T. M. J. d'Offay, Ch.B., F.R.C.S., and Thomas B. Mouat, Ch.M., F.R.C.S. Philadelphia, The Blakiston Co., 1940. $5.50.

This is the first edition of the translation into English of a book, written by a French surgeon, which has reached its third edition in France.

It is a very detailed study of every pathological condition of the hand and fingers. The minutest details of the anatomy, physiology, and pathology of each condition are given with illustrative case histories. There are many excellent drawings and a few photographs.

One gains the impression that some of the treatment advised is too detailed and exacting to be used by the average practitioner. For instance, the only treatment advised for a subungual hematoma is bilateral incision along the nail bed, and removal of all the nail raised by the hematoma,—exactly the treatment advised for a subungual whitlow. However, the author emphasizes the necessity of thorough attention to what may appear to be minor injuries, but which may be disabling for long periods of time.

One of the translators calls attention to the true use of the word "débridement", which means "enlargement of the wound". This treatment was first advocated in 1789, before the days of anaesthesia, and then the term did not refer to the procedure now associated with the word,—namely, excision of devitalized tissue.

ORTHOPÄDIE UND KINDERHEILKUNDE. IN AUSGEWÄHLTEN KAPITELN (Orthopaedics and Pediatrics, with Selected Subjects). Prof. Dr. Max Lange. Supplement to *Archiv für Kinderheilkunde*. Stuttgart, Ferdinand Enke, 1940.

This interesting seventy-five page supplement to the *Archiv für Kinderheilkunde* is truly a short cut to children's orthopaedics. The diagnostic material is excellent. The treatment follows the dictates of the Lange school, which is at considerable variance with American treatment. There is no attempt to include any new material. The booklet has little of interest to orthopaedic surgeons but should prove valuable to pediatricians for whom it is intended.

SYNOPSIS OF THE PRINCIPLES OF SURGERY. Jacob K. Berman, M.D., F.A.C.S. St. Louis, The C. V. Mosby Co., 1940. $5.00.

As its title implies, this new volume is not so much a description of surgical diseases or an exposition of surgical operative techniques as it is a discussion of the correlation of the basic sciences with the fundamental principles of surgery. After a brief review of the history and methods of surgery, it outlines the practical applications of embryology, anatomy, histology, bacteriology, and pathology, and discusses the general aspects of local, specific, and systemic infections. Most important of all, it explains the relation of biochemistry and physiology to the understanding of anoxia, shock, hemorrhage, endocrine dysfunction, and subhydration, and to "the proper evaluation of such states as acidosis, alkalosis, tetany, and calcium imbalance". The brief chapter on acid-base balance may particularly be cited as an admirable example of this type of discussion.

Naturally in a volume relatively so small (615 short pages) and with so wide a field of survey, the descriptions of the surgery of the various body systems is extremely condensed. The chapter on the skeletal system, for example, is by no means a complete treatise on orthopaedic surgery, nor is that on the reproductive and urinary systems an adequate presentation of gynecology and urology. These facts, however, are not faults, but are inherent in the purpose and scope of this admirable work. Especial praise is due also to the excellent illustrations, 274 in number, and to the selected references which are appended to each chapter and which should inspire the student and the practising surgeon to further and original study.

STUDIEN ÜBER 111 NACHUNTERSUCHTE FÄLLE VON CALCANEUSFRAKTUREN UNTER BESONDERER BERÜCKSICHTIGUNG DER GELENKSCHÄDEN ZWISCHEN TALUS UND CALCANEUS. (Follow-up Studies of 111 Fractures of the Os Calcis.) Albert Ahlberg, M.D. Göteborg, Elanders Boktryckeri Aktiebolag, 1940.

This monograph is devoted to the follow-up study of 111 out of a total of 160 os calcis fractures seen between 1925 and 1937. All of the patients were personally reexamined by the author. The results of these examinations have been studied with most meticulous attention to almost all the problems which might arise in the mind of any surgeon. All controversial problems concerning the methods of therapy are discussed in detail. In general, the author favors the closed method of treatment in fresh fractures. He notes that in severely comminuted cases anatomical reposition is not to be expected, even by the methods advanced by Böhler. However, it is pointed out that this is not the invariable prerequisite of good function. Cases in which only fair reposition has been accomplished may have good function, while, on the other hand, those with excellent reposition might have marked disability. In the old cases, subastragalar fusion is recommended for those presenting symptoms of dysfunction.

It would be fruitless to attempt to abstract the information contained within this volume, which is replete with the facts and figures of the most intelligent and painstaking work. In addition to a large and carefully chosen list of references, the histories of all the cases studied are included.

This volume probably presents by far the most critically analytical study of calcaneum fractures which has yet appeared. No one interested in the subject can afford to neglect this excellent treatise.

GRADUATE MEDICAL EDUCATION. Report of Commission on Graduate Medical Education. Chicago, Chicago University Press, 1940.

The methods for promoting graduate education are discussed in the Commission's report from three points of view: that of the intern, the resident, and the practitioner who has been out of medical school for a few years and settled in a country or small town district.

Two influences are operating in these times to emphasize the need for opportunities

for graduate instruction,—namely, the extraordinarily rapid advances being made in biochemistry, physiology, chemotherapy, and immunology; and the efforts of the various specialties to insure the public against inadequately prepared specialists by requiring those desirous of entering a special line of practice to pass a rigid examination, after spending a year or two in advanced studies in the basic sciences and from two to five years in a hospital residency. This latter requirement applies, without much modification, to the individual who has spent a few years in general practice and decides to enter a specialty. No one can deny the advantages and satisfactions to the individual that such a program offers. Over against this must be set the already manifest tendency for those who have fulfilled the almost compulsory requirement of a hospital internship, to supplement that service by a residency, irrespective of whether they plan to enter general or specialized practice. This will delay their engaging in gainful practice until after they are beyond thirty years of age.

For the individual who has established himself in practice and wishes to keep abreast of the advances in medicine but finds it difficult, if not impossible, to give up time to visit the large medical centers for intensive postgraduate study, many of the State Societies are carrying out programs which are brought to the physician's door, through cooperation of medical school faculties, libraries, and local hospitals.

This report provides food for thought to those concerned *about* as well as those who are concerned *with* medical education.

MANUAL OF GRADUATE TRAINING IN SURGERY. Chicago, American College of Surgeons, 1940.

Pursuant to its aim of raising the standards of surgery, the American College of Surgeons has published a twenty-four-page "Manual of Graduate Training in Surgery", in which are incorporated the requirements for its approval of programs of training in general surgery and the surgical specialties in hospitals of the United States and Canada.

The Manual is the outcome of ten years of study of educational programs in surgery by the Board of Regents and several committees of the College. In 1937 a Committee on Graduate Training in Surgery was established, under whose direction the field staff of the College personally surveyed a selected group of hospitals in connection with the work of the Hospital Standardization Department. Based on the findings of those surveys, "Fundamental Principles and Criteria" were developed which have been applied in the evaluation of plans for graduate training in surgery.

The Minimum Standard for Graduate Training in Surgery which is included in the new Manual comprises five clauses, concerned with (1) duration and objective of the program, (2) organization and supervision, (3) basic medical sciences, (4) clinical material, and (5) organized study.

Under the requirements, an acceptable program requires a minimum of two and preferably three or more years of training in surgery, beyond at least one year of general internship. Such preparation is now necessary in order for an applicant for fellowship in the American College of Surgeons to meet the qualifications in respect to training.

Dr. Dallas B. Phemister, Department of Surgery, University of Chicago School of Medicine, is chairman of the Committee.

SYNOVIOMA (SYNOVIALOMA) OF THE FOOT. REPORT OF A CASE. William C. Black. *The American Journal of Cancer*, XXXIX, 199, June 1940.

A synovial tumor of the foot is described. It is thought to be benign and of bursal origin. The tumor cells exhibit divergent capacities for differentiation and are associated with a mucinous and cartilaginous matrix. The literature relative to synovial tumors of bursae is reviewed. Excellent photomicrographs illustrate the report.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

CONTRIBUTION TO THE PATHOGENESIS OF MULTIPLE HEREDITARY OSTEOCHONDROMATOSIS. Sheldon A. Jacobson. *The American Journal of Cancer*, XXXIX, 220, June 1940.

Experimental evidence based on histological studies of bone formation in dogs is presented to demonstrate that wherever cartilage and bone, however formed, are growing together, a mutual polarity may result. By virtue of this polarity an epiphysis-like structure is produced. This, if true, would adequately explain the epiphysis-like architecture of cartilaginous exostoses. Three dogs were employed in the experiments. In one instance a fracture was produced through the tibia, and histological studies were made on the thirty-second day. In the other two instances, bladder mucosa was implanted in the rectus muscle to stimulate bone formation.

Photomicrographs are presented, which in part bear out the author's contention that an epiphysis-like arrangement of cartilage and bone occurs.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

THE SCALENUS ANTICUS SYNDROME WITH AND WITHOUT CERVICAL RIB. Joseph Donald and Benjamin F. Morton. *Annals of Surgery*, CXI, 709, May 1940.

The authors present an analysis of twenty-one cases of scalenus anticus syndrome observed by them in the past two years. Sixteen of these twenty-one patients have been operated on by scaleniotomy, of whom fourteen were completely relieved and two partially; the other five are awaiting operation.

The age of these patients ranged from fifteen to fifty-four with an average of thirty-seven years. Females predominated over males. There were nine left-sided cases, eight right-sided, and three bilateral.

Histories revealed that excessive or unusual use of the involved extremity preceding the onset of symptoms occurred in eight cases; five cases were servants who used the arm for sweeping or washing. One case developed immediately after a direct trauma, and two after general anaesthesias during which the shoulder posture was faulty.

The symptoms varied in duration from six weeks to eleven years, half of them existing for less than six months. The outstanding symptoms and physical findings were pain, numbness, tenderness over the scalenus anticus, muscle weakness, and occasionally atrophy. Many cases showed changes in tendon reflexes and sensation. Vascular findings of decreased blood pressure, bruits, and, in severe cases, gangrene were frequently present. Only four had cervical ribs, but the symptoms were more extreme in these cases. A chart summarizing the twenty-one cases is given.

The authors conclude that scaleniotomy is the treatment of choice in scalenus anticus syndrome when conservative treatment is inadequate to give relief; the symptoms are produced by inherent anatomic variations in the shoulder girdle, such as low origin of brachial plexus, etc.; and the precipitating conditions are trauma, occupational strain, or improper posture.—*Frank Kugler, M.D., Iowa City, Iowa.*

THE CERVICOBRACHIAL SYNDROME. A Discussion of the Etiology with Report of Twenty Cases. Kenneth H. Aynesworth. *Annals of Surgery*, CXI, 724, May 1940.

The author proposes that the term "cervicobrachial syndrome" be applied to those cases usually called scalenus anticus syndrome. He believes the suggested nomenclature to be better, because the characteristic symptoms and signs are produced not alone by abnormal function of the scalenus anticus muscle but by various other structures,—for example, cervical rib, normal first thoracic rib, clavicle, cervical nerve trunks, subclavian artery, and sympathetic and vasomotor nerves.

He groups the symptoms into three categories: (1) neurological symptoms,—numbness, pain, paralysis and loss of function; (2) vascular symptoms,—moderate pain, œdema, swelling, obstruction of blood flow with thrombosis and aneurysm formation; and (3) a combination of neurological and vascular symptoms.

In the literature many diverse theories have been produced to explain the etiology of this condition. The author lists and discusses these and favors trauma as the most important contributing element.

Twenty cases are reported, in 80 per cent. of which trauma was present. Twelve patients were treated by section of the scalenus anticus, and all were relieved.—*Frank Kugler, M.D., Iowa City, Iowa.*

SEMILUNAR CARTILAGES. Frank P. Strickler. *Annals of Surgery*, CXI, 892, May 1940.

The author describes the mechanism of injury to the internal semilunar cartilage. He points out that in about one-third of the cases, cartilage injury is not associated with locking of the knee joint.

He has devised several instruments to reduce the surgical trauma. These consist of angulated hooks for grasping the cartilage, a right-angle knife for cutting the cartilage, angulated scissors, and two sets of retractors.

He describes his surgical technique, and lays stress on the postoperative treatment. He does not believe in immobilizing the knee, but applies a compression dressing, places the knee slightly flexed on a pillow, and uses ice packs and small amounts of opiates to control pain.

In one or two days after the operation his patients walk with one crutch. He believes that early walking and weight-bearing prevent adhesions, diminish muscle atrophy, and shorten convalescence. His patients are back at work in four or five weeks.—*O. B. Bolibaugh, M.D., San Francisco, California.*

LEG AMPUTATIONS IN DIABETIC GANGRENE. Saul S. Samuels. *Annals of Surgery*, CXII, 105, July 1940.

The author states that there are two major indications for amputation in diabetic gangrene: (1) rapidly spreading gangrene with no signs of healing or formation of a line of demarcation, and (2) uncontrollable infection of the foot. All of these cases have inadequate arterial circulation.

The author claims that teaching in the past has been to the effect that closed amputation in these cases is dangerous, because of the likelihood that the infection would spread throughout the body and into the thigh; therefore, guillotine or modified guillotine amputations should be done. (The reviewer does not believe this teaching has been universal.) The author states that the mortality in this type of procedure has been as high as 75 per cent. in some hospitals. He goes on to state that the fear of infection is groundless, and, if a simple procedure is carried out and proper postoperative care is given, the mortality will be low. He also advocates simplification of the preoperative treatment. If the patient is not dehydrated, transfusions and intravenous injections of glucose and saline with insulin coverage are not necessary. If infection is present, it will be difficult or impossible to bring the blood sugar down within normal limits, and delay may be disastrous. Immediate operation should be performed regardless of the diabetic status.

Cyclopropane is the best anaesthetic. If this is not available nitrous oxide should be used. The use of spinal anaesthetics is not advisable.

He describes the method of amputation in detail, including the method of draping. No tourniquet is used. A circular incision is made at the level of the upper border of the patella, at which level the muscles are also cut. Vessels are clamped as they are cut. The sciatic nerve is not injected with alcohol. The femur is sawed through two inches proximal to the level of the skin incision. Vessels are ligated with silk, which is also used to close the muscles and skin. No drains are used.

The patient may be allowed out of bed on the day following the amputation, and may be in a wheel chair every day thereafter. On the sixth or seventh day sutures are re-

moved, and the patient may go home one to four days later. Postoperative care of diabetics is the same as before.

In thirty-three amputations performed by the author the mortality was 9 per cent.

The author describes a similar technique for amputations below the knee.—*O. B. Bolibaugh, M. D., San Francisco, California.*

FRACTURE OF THE CAPITELLUM. REPORT OF A CASE SUCCESSFULLY TREATED BY CLOSED REDUCTION. Edward F. McLaughlin. *Annals of Surgery*, CXII, 122, July 1940.

The author reports a case of fracture of the capitellum successfully reduced by closed manipulation. He describes the method of reduction as follows: Strong traction was placed on the forearm with the elbow in complete extension, and firm pressure over the anteriorly displaced capitellum, the elbow was then brought up quickly into acute flexion at which time the fragment slipped into its proper location. With supervised early active motion and massage, full motion was obtained in about three weeks. A later roentgenogram showed complete healing.

In the literature reviewed, most writers recommended removal of the fragment or open reduction with mechanical fixation. The author of this paper believes that closed reduction with early motion is the method of choice.—*O. B. Bolibaugh, M.D., San Francisco, California.*

CYST OF THE SEMILUNAR CARTILAGE. DeForest P. Willard and Jesse T. Nicholson. *Annals of Surgery*, CXII, 305, Aug. 1940.

The authors report the case of a girl, eleven years old, with a cyst of the internal semilunar cartilage.

They discuss the etiology and pathology. A review of the literature reveals that 200 cases were reported prior to 1939, only thirty cases of which involved the internal semilunar cartilage.

The authors do not believe that trauma plays an important part in the etiology. The microscopic detection of villi, and an endothelial lining would strongly indicate that these cysts result from a developmental fault.—*O. B. Bolibaugh, M.D., San Francisco, California.*

AFTER-CARE OF FRACTURES WITH SPECIAL REFERENCE TO DELAYED UNION AND SUDECK'S ATROPHY. Henry H. Jordan. *Archives of Physical Therapy*, XXI, 25, Jan. 1940.

Thirty-eight years after his original article, in which he described the acute bone atrophy with its typical roentgenographic appearance, Paul Sudeck, as a result of further histological and experimental findings, now believes that the original atrophy named after him is not an atrophy at all and not a pathological condition. It should be called "acute collateral transformation".

While Sudeck considers that the acute collateral bone transformation following fractures, or any injury of sufficient strength, is a regular physiological reaction, is not pathological, and does not require treatment, the author is convinced from his clinical experience that the mottled appearance in the roentgenograms, evident in only a moderate proportion of his cases, indicates an unfortunate disturbance in the healing process. Regardless of the condition of the original lesion, acute collateral bone transformation is almost invariably accompanied by pain and disability on weight-bearing, and continues as long as the roentgenograms show signs of decalcification. Clinically, the appearance of these symptoms indicates that treatment is required.

The writer believes that weight-bearing with adequate walking, and other exercises, in an unpadded cast, plus support and more support, is the most effective method of treating this condition. He questions the advisability of local stimulation by physiotherapy.—*C. D. Moffatt, M.D., Iowa City, Iowa.*

THE IDENTITY OF MYOTONIA CONGENITA (THOMSEN'S DISEASE), DYSTROPHIA MYOTONICA (MYOTONIA ATROPHICA) AND PARAMYOTONIA. Otto Maas and A. S. Paterson. *Brain*, LXII, 198, 1939.

These authors traced the conception of the syndrome of myotonia congenita in the literature and examined in detail all those characteristics of the disease which other authors have tried to distinguish from myotonia atrophica. The authors point out that all the cases of myotonia congenita that have been followed over the years have shown changes in the musculature and endocrine disturbances which earmark dystrophia myotonica.

The authors also point out that in cases of paramyotonia, a symptom complex of myotonia, which occurs in cold weather, will reveal that other members of the family have dystrophia myotonica. This disease may be just a variant of the original myotonia congenita.—*L. A. Russin, M.D., Iowa City, Iowa.*

DISLOCATION OF THE INFERIOR RADIO-ULNAR JOINT AS A COMPLICATION OF FRACTURE OF THE RADIUS. Geoffrey Hyman and F. R. R. Martin. *British Journal of Surgery*, XXVII, 481, Jan. 1940.

Ten cases of dislocation of the inferior radio-ulnar joint are described in detail, and fifteen others are discussed briefly. The following classification is made:

"*Group I.*—Anterior dislocation of the head of the ulna as a component of a severe Colles's fracture.

Group II.—Posterior dislocation of the head of the ulna associated with: (*a*) fracture of the shaft of the radius (6 cases); (*b*) fracture of the lower inch of the radius (2 cases).

Group III.—Anterior dislocation of the head of the ulna with fracture of the shaft of the radius (2 cases)."

The treatment is not difficult and can usually be accomplished without open operation. The prognosis for complete recovery is excellent.—*Ernest M. Daland, M.D., Boston, Massachusetts.*

THE AETIOLOGY OF HALLUX RIGIDUS. E. A. Jack. *British Journal of Surgery*, XXVII, 492, Jan. 1940.

In the group of cases studied, this condition was found to precede or to accompany the early stages of pes planus. There was usually evidence of an incompetent first metatarsal segment.

The mechanism by which this defect may be responsible for both conditions is suggested, and this theory is supported by pathological findings.—*Ernest M. Daland, M.D., Boston, Massachusetts.*

A FURTHER REVIEW OF THE INTERINNOMINO-ABDOMINAL OPERATION: ELEVEN PERSONAL CASES. Gordon Gordon-Taylor. *British Journal of Surgery*, XXVII, 643, Apr. 1940.

The writer reviews five cases previously reported and adds six more cases of hindquarter amputation for sarcoma. New points in technique are mentioned. Death followed operation in four out of eleven cases. Three patients have remained free from disease for eleven, five, and three years respectively. In two, there was recurrence within a year, and in one at the end of five years. The other is a recent case.—*Ernest M. Daland, M.D., Boston, Massachusetts.*

COLLES'S FRACTURE. J. H. Mayer. *British Journal of Surgery*, XXVII, 629, Apr. 1940.

"1. The results of Colles's fractures treated by present methods are extremely disappointing, redisplacement being exceedingly common even after perfect reduction.

2. An essential part of the displacement in most cases is a rotation of the lower radial fragment into supination, but this usually passes unrecognized.

3. The radiological appearances of such a 'supination-twist' are characteristic, and have been enumerated by X-raying experimental fractures in dissected specimens.

4. The triangular fibrocartilage of the inferior radio-ulnar joint plays a vital part in the mechanism of the fracture, and the inferior radio-ulnar joint is probably damaged in the majority of cases. Such damage may be recognized radiologically, and its proper repair must receive due attention.

5. Splintage in full pronation, with the flexed elbow included in the plaster, has proved to be the method of choice as a guard against redisplacement in all cases with a supination-twist and in all with damaged inferior radio-ulnar joints, with the single exception of those with a fracture of the neck of the ulna.

6. The anatomical and functional results in a short series so treated are considerably better than in a consecutive series treated by other methods, and it is hoped that this method will be afforded a more extensive trial."—*Ernest M. Daland, M.D., Boston, Massachusetts.*

A New Conception of Parathyroid Function and Its Clinical Application. A Preliminary Report on the Results of Treatment of Generalized Fibrocystic and Allied Bone Diseases and of Rheumatoid Arthritis by Aluminum Acetate. Arthur J. Helfet. *British Journal of Surgery*, XXVII, 651, Apr. 1940.

The theory is advanced that parathormone exerts its primary effect on the phosphorus metabolism, and that treatment should be based on the control of the phosphorus intake.

A new classification of hyperparathyroidism is offered:

1. Primary hyperparathyroidism due to an adenoma, with fibrocystic disease, high blood calcium, and a low blood phosphorus;
2. Secondary hyperparathyroidism—
   - *a.* Simple, compensatory, or physiological with normal blood chemistry and either normal or hyperplastic tissue in the gland;
   - *b.* Pathological, where an adenoma has been superimposed on one of the conditions in the previous group (2, *a*). This is clinically similar to primary hyperparathyroidism (1) but reverts to the simpler type (2, *a*) after removal of the adenoma.

A method of lowering the phosphorus intake consists in feeding a soluble salt of aluminum,—aluminum acetate. The dosage and methods of administration are discussed. A pint of milk is also given daily. The same treatment has been used in rheumatoid arthritis on the supposition that this is a type of hyperparathyroidism.

Case reports of four cases of generalized osteitis fibrosa cystica and nine of rheumatoid arthritis treated in this way are given. The results seem to be very satisfactory.—*Ernest M. Daland, M.D., Boston, Massachusetts.*

Osteo-Arthritis of the Hip. L. W. Plewes. *British Journal of Surgery*, XXVII, 682, Apr. 1940.

A study has been made of 242 cases of osteo-arthritis of the hip. The most common causes were injury, slipped epiphysis, and arthrokatadysis.

Treatment is at first conservative and includes rest, and physiotherapy. Quite recently, deep x-ray therapy has been used with encouraging results. Operative treatment on those failing to improve with conservative measures consists in reconstructive operations, excision of the head and neck of the femur, and arthrodesis.—*Ernest M. Daland, M.D., Boston, Massachusetts.*

Um caso de síndroma de Sudeck-Leriche curado pela acetylcholine (A Case of Sudeck-Leriche Syndrome Healed by Acetylcholine). F. de Moraes. *Bulletin de la Société Belge d'Orthopédie*, XI, No. 6, July–Aug., 1939.

A case of the syndrome of Sudeck-Leriche or acute painful posttraumatic osteoporosis, is presented in which the paradox sympathectomy of Leriche was replaced by

simple medical treatment, principally injections of acetylcholine. The patient was a woman sixty years of age, who had a distortion of the left foot. Hot air and hot baths, as well as daily injections of 0.10 grams of acetylcholine were prescribed. After the third injection the pain had almost disappeared, and the patient was able to walk with a cane. There was a recurrence of the condition and the patient was again treated by the injection of 0.10 grams of acetylcholine three times a week. After the eighth injection the clinical signs had disappeared. The case presented is typical of posttraumatic osteoporosis and similar cases have been reported by Leriche, Jung, and many others. It seems certain that a novocaine infiltration of the injured ligaments immediately after the accident might have prevented the development of the acute phases of the traumatism.

The author concludes that in the presence of Sudeck-Leriche's syndrome, acetylcholine, hot air and hot baths should be tried before sympathectomy; that the reaction of this hyperaemic therapeutic drug is rapid; and that in case the patient does not respond, the sympathectomy of Leriche is indicated.

Before considering the cure definite and complete, it is necessary to show in the x-ray picture that there is recalcification, although the latter never retains normal intensity.—*Arthur Steindler, M.D., Iowa City, Iowa.*

AMPUTATION THROUGH THE LOWER THIRD OF THE FEMUR: A MODIFIED TECHNIQUE. Clarence E. Rees. *California and Western Medicine*, LIII, 64, Aug. 1940.

A simplified technique is outlined for low amputation of the femur. A circular skin incision is made with the patient in the prone position. The surgeon can thus obtain better accessibility to vessels and nerves, and can secure an excellent flap of tendons, muscles, and fascia with a minimum of trauma and the preservation of the maximum blood supply. A single silk suture is passed through the tendons and tied over the end of the femur. The author reports excellent results from this simplified and rapid technique.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

THE CORROSION OF METALS IN TISSUES; AND AN INTRODUCTION TO TANTALUM. George L. Burke. *The Canadian Medical Association Journal*, XLIII, 125, 1940.

In this article, Dr. Burke discusses the question of the corrosion of metals in tissues and the disadvantages of many of the alloys, and tells of the results of his experiments with the use of tantalum. He gives the mechanical properties of tantalum and the analysis of its composition, and states that it is comparable to steel in strength and workability; that unannealed its tensile strength is comparable to that of cold rolled steel, and that, annealed, it is as strong as annealed steel. Tantalum can also be drawn into wire, machined, and variously shaped. The author reports the successful results he has obtained with this metal, notably as suture material.

LIPOID GRANULOMATOSIS OF THE BONES WITHOUT SYMPTOMS OF SCHÜLLER-CHRISTIAN DISEASE. I. Snapper. *Chinese Medical Journal*, LVI, 303, 1939.

The author gives a short discussion of Schüller-Christian disease in which are found the characteristics of multiple defect in skull, exophthalmos, diabetes insipidus, and pituitary disturbance.

The author presents three cases with cystic degeneration of various bones in which the calcium, phosphorus, and phosphatase were normal. Each patient had a fracture through the affected zone. There was very slight rise in cholesterol. No exophthalmos, diabetes insipidus, or skull localizations were found. Biopsy through regions of relatively fresh lesions showed xanthoma cells. In one case biopsy was performed three times.—*G. Miyakawa, M.D., Iowa City, Iowa.*

BEOBACHTUNGEN AN DER KNIEGELENKKAPSEL MITTELS POSITIVER KONTRASTFÜLLUNG UND RÖNTGENDURCHLEUCHTUNG (Observation of the Knee Joint Capsule by the Injection of Contrast Material and X-ray). H. R. Paas. *Deutsche Zeitschrift für Chirurgie, CCLII*, 478, 1939.

The author describes a method of observation of the knee joint by the injection of a contrast material known as "Abrodil" 20 per cent. and "Perabrodil" 35 per cent. Experimental work was done on dogs. Some of his observations and conclusions may be summed up as follows:

The resorption time of the material depends on the age of the patient and the condition of the joint. The faster the resorption, the more acute the inflammation of the joint capsule. As to the physiological state of the joint the examination should show:

1. The tension and space of the joint depending on the position of the joint during the examination. In extension the anterior part of the capsule is in lower tension, and in flexion the posterior part is in lower tension.

2. In a normal state, the capsular apparatus has very marked elasticity, but forceful stretching is not without consequence if applied continuously.

3. In advanced age, and after a long period of non-weight-bearing, there is a structural shortening of the capsule which takes place with loss of elasticity.

The changes mentioned are due to pathological changes of the joint and thus give a complete picture pointing to the lesion. The injected material depends on several conditions. Non-weight-bearing as well as advanced age diminish the ability of the capsule to resorb those materials. Active and passive motion, as well as acute inflammatory processes, increases resorption.—*T. J. Greteman, M.D., Iowa City, Iowa.*

THE PATHOLOGICAL SIGNIFICANCE OF INTRA-ARTICULAR PRESSURE. Ernst Freund. *Edinburgh Medical Journal*, XLVII, 192, Mar. 1940.

Under certain pathological conditions such as intra-articular hemorrhage and effusions, the intra-articular pressure, which in the normal joint is negative and amounts to from minus 60 to minus 70 millimeters of water, may increase to a positive pressure up to plus 70 millimeters of water. There may result under such conditions, cystlike excavations invading the epiphysis from the joint, and also a dislocation of the joint contents under the action of weight-bearing and muscular strain. Most severe lesions occur in haemophilic arthritis with destruction of the whole epiphysis. In other forms of arthritis, such as rheumatoid, syphilis, and Charcot's disease, remarkable changes are also encountered. Various types of herniae are described, from a single flasklike excavation with a small opening, to multiple deep cavities, resulting from pressure of long duration. The cells and fibers of the connective tissue of the underlying bone marrow become distended in concentric arrangement with the formation of a capsule. With progression of the herniation, the pressure may be transmitted to adjacent tissues. The bone trabeculae in the way are absorbed by osteoclasts and the cartilage by chondroclasts. The zone of provisional ossification of cartilage not supported by bone, is broken into pieces visible by microscopic examination. If the pressure acts on the side of the bone normally not covered by cartilage, a bay undermining the cartilage results. Here, while absorption is proceeding in the outer layers, there is deposition of new bone on the inner surface. Where the cortex is atrophic, and gaps in the continuity of the bone allow hernial formation, periosteal layers of the synovial membrane may furnish the material for the capsule of the hernia. Contents of the cavity vary from the hematoma in haemophilia to the fibrinoid masses in rheumatoid arthritis. Pieces of detached cartilage and necrotic bone, intermingled with cells, blood, and detritus derived from the joint cavity, are also found.

The course depends upon the balance between the injuring agent and the resistance of adjacent bone tissue. It may go on to extensive destruction or may undergo reparative changes.

The clinical significance of the findings are: (1) Knowledge of lesions is a help in diag-

nosis; (2) increased intra-articular pressure impairs nutrition of the joint structures, especially cartilage; and (3) increased intra-articular pressure produces symptoms distinguishable by ordinary examination.

Treatment should be by prophylaxis; removal of fluid by puncture, drugs, physiotherapy, and dietetics; immobilization; and non-weight-bearing.—*J. Y. Sher, M.D., Iowa City, Iowa.*

High Ligation of the Femoral Vein in Amputations of the Lower Extremities. A Preliminary Report Based on Twenty-Eight Amputations of the Thigh. J. Ross Veal. *The Journal of the American Medical Association*, CXIV, 1616, April 27, 1940.

The mortality rate for amputation of the lower extremity is high and out of proportion to other operative procedures.

The author reviewed 171 cases of amputation and found the mortality to be 39.1 per cent.; the majority of deaths were due to pulmonary complications.

Following a study of the anatomy of the leg in relation to blood supply and of the autopsy findings in patients who have submitted to amputation, the author believes these pulmonary complications can be explained on the basis of embolic phenomena. He found the femoral vein to be devoid of tributaries up to the deep profunda in many specimens examined. This resulted in thrombosis up to the deep profunda and some extension of the thrombus into the junction of these two vessels, all of which is conducive to the formation of the emboli.

For this reason the author advises high ligation of the femoral vein just distal to the saphenofemoral junction. Amputations in twenty-eight consecutive cases with low mortality bear out the above theory.—*W. C. Peterson, M.D., Dallas, Texas.*

Paget's Quiet Necrosis. J. C. R. Hindenach. *The Lancet*, II, 20, 1939.

There is much confusion among modern authors as to the term "Paget's quiet necrosis". In order to clear this, the writer has quoted the original work of Paget, including his case report in which he describes the process as one of local necrosis and sequestrum formation in the superficial layers of the shaft of a long bone. The lesion is chronic from the beginning, and affects mainly young adults. There is a minimal amount of suppuration surrounding the sequestrum, and sinuses are not formed. It is probably the result of a chronic osteitis due to a rather non-virulent staphylococcus.

The writer quotes descriptions from four modern textbooks of surgery, which show the disagreement between them.—*Frank Kugler, M.D., Iowa City, Iowa.*

Toxoid Treatment of Recurrent Infection After Staphylococcal Osteomyelitis. F. C. O. Valentine and E. C. B. Butler. *The Lancet*, I, 914, May 18, 1940.

The authors studied thirty cases of recurrent staphylococcal infection after osteomyelitis and made an effort to determine the value of a toxoid in maintaining the level of immunity and lessening the tendency toward further attacks. They are of the opinion that osteomyelitis is usually caused by potent leukocidin-producing strains of staphylococcus and they, therefore, think that it is important to use a toxoid containing a potent leukocidal factor. They found that antitoxins in the serum of patients with recurrent staphylococcal infection were seldom high and often within normal limits. They point out that treatment by toxoid injections may sometimes sensitize the tissues, and so precipitate an eruption of a latent focus, but feel that such a focus would probably have become active at some later date when immunity was low. The authors state that it is reasonable to hope that the toxoid will make recurrence less likely and, if it comes, less severe.—*Lenox D. Baker, M.D., Durham, North Carolina.*

TREATMENT OF FRACTURES OF UPPER THIRD OF SHAFT OF FEMUR. J. R. Armstrong. *The Lancet*, I, 957, May 25, 1940.

The author points out that the typical deformity of these fractures—flexion, and abduction of the upper fragment—is caused by the action of the psoas and short muscles inserted on the greater trochanter, while the posterior, inward, and upward displacement of the lower fragment is due to the action of the hamstring and adductor muscles. He condemns the use of the Braun-Böhler frame in this fracture because it does not allow more than 30 degrees of flexion at the hip, which, as the flexion deformity of the proximal fragment is usually about 50 degrees, is insufficient. He advocates the use of a Thomas splint with a bent-knee attachment slung from a Souttar's modification of a Balkan beam to procure traction in the long axis of the femur with the hip in any degree of flexion required. He stresses the importance of having the ring fit closely around the thigh and bear on the posterior surface of the tuberosity of the ischium, in order that the pull of countertraction may be transmitted to the pelvis, and not on the femur below the tuberosity, which would increase the flexion deformity of the proximal fragment. The author warns against early weight-bearing. His methods of applying traction are described in detail, and his paper is well-illustrated.—*Lenox D. Baker, M.D., Durham, North Carolina.*

SULPHAMETHYLTHIAZOLE IN EXPERIMENTAL STAPHYLOCOCCAL INFECTIONS. A. Macdonald. *The Lancet*, I, 1157, June 29, 1940.

The author points out that the use of sulphanilamide and its derivatives in the treatment of staphylococcus aureus infections in man has been disappointing. He studied the efficacy of sulphamethylthiazole in staphylococcus infections in mice. From his experiments with 200 mice, he concluded that both sulphamethylthiazole and sulphapyridine given by mouth prevented many of the early deaths in experimental staphylococcus infections in mice but are less efficient after abscesses have begun to form; that none of the sulphanilamide drugs is particularly active in the presence of pus; and that the experiments with skin abscesses may indicate that sulphamethylthiazole does not completely overcome this difficulty.—*Lenox D. Baker, M.D., Durham, North Carolina.*

CLOSED PLASTER TREATMENT OF INFECTED WOUNDS. G. R. Girdlestone. *The Lancet*, II, 31, July 13, 1940.

The author points out that the success of the closed plaster method depends on its correct application to the individual case. He calls attention to the necessity of proper débridement, and the proper application of the cast in order that an even, gentle pressure, similar to that normally exercised by the fasciae and the skin, is exerted over the exposed tissues. He warns against condemning the method because it has failed in the hands of surgeons imperfectly familiar with the method. He states, "He who would apply plaster in war must be skillful in its use, or he will be a danger to his patients and bring undue discredit on the method; he had far better continue to treat wounds on more familiar lines. . . . If a wound is to do well it must first be given appropriate operative treatment: after this the progress of the wound and the comfort of the patient depend on the fit and inner smoothness of the plaster."—*Lenox D. Baker, M.D., Durham, North Carolina.*

THE CLASSIFICATION OF REPRINTS OF ARTICLES IN AN ORTHOPAEDIC LIBRARY. Sidney Pappworth. *The Liverpool Medico-Chirurgical Journal*, XLVI, Part II, 144, 1939.

In this article Mr. Pappworth describes the system which he devised for use in the Hugh Owen Thomas and Robert Jones Memorial Library at the Liverpool Medical Institution, in which there are an extremely large number of books and reprints.

The author discusses the defects and difficulties met with in the various systems of classification now in use, and the need of some method which not only the library, but the surgeon may follow in filing literature in order to allow easy reference at any time.

He states that the system of the British Orthopaedic Association is too broad in its grouping and that it is one of diseases only, and, therefore, does not allow in the classification other conditions which it is necessary to include.

Mr. Pappworth's system, with certain additions, is based on diseases with groupings and subgroupings arranged, as he says, in the order which he would use if he were writing a textbook on orthopaedic surgery. He then gives his classification, including the main and the subgroups and the contents of each. The simplicity of the system will appeal to the physician, as will the means advocated for adding subjects not classified under disease.

This method of classification should be of use to the orthopaedic surgeon, and the system is applicable to any department of medicine or surgery. Those interested in the difficult problem of filing reprints should certainly consult this article.

DÉBRIDEMENT. M. R. Charlton. *The Military Surgeon*, LXXXV, 129, 1939.

Early in the World War the only patients operated upon were those with hemorrhage, severe wounds needing amputation, wounds of the skull and viscera, and those of long standing with fully developed infection. Other wounds were treated expectantly, that is, were expected to become infected—and they did. The results were bad in regard to mortality, permanent disability, and prolonged hospital care. In débridement, which began in the War in 1914, the tract is first mapped out; healthy tissue cut with anatomical sharp dissection; and devitalized tissue, foreign bodies, and muscle, which is infiltrated with blood and does not contract when pinched with forceps, removed. Bone fragments are removed freely in compound fractures. The wounds are packed with gauze and most of them left open. The author believes that even well-trained civilian surgeons find difficulty with military débridement, the evacuation-hospital operation. He gives the contra-indications and indications for débridement as follows:

1. Clean, perforating wounds of soft parts, by rifle or machine gun bullet, not involving nerves, blood vessels, or bone do not need débridement.
2. No débridement is usually required for compound fractures by perforating bullets unless there is extreme comminution.
3. Superficial gutter wounds not involving muscles may be treated conservatively.
4. All obviously infected or badly lacerated wounds, those with foreign bodies, or involving blood vessels, nerves, or bone, and all wounds of the skull and contents require immediate operation.
5. All perforating or penetrating wounds of the abdomen need débridement.
6. Continued hemorrhage is the criterion for operation in chest wounds.
7. Wounds from high explosives need rigorous treatment, as shell fragments cause damage out of proportion to their size.—*Samuel Levine, M.D., Iowa City, Iowa.*

ARTIFICIAL LIMBS. A. Steindler. *The Military Surgeon*, LXXXVI, 560, June 1940.

The writer describes the historical development of the artificial limb. He mentions the increasing use of these prostheses in the modern day, due to war and civil injuries. In the United States the annual demand is now 22,500.

General principles of amputation are discussed, including sites of amputation, prevention of contractures, rules for after-treatment, and types of bearing points. In conclusion, materials and methods of construction of prostheses are given.—*Frank Kugler, M.D., Iowa City, Iowa.*

MARCH FOOT. Henry W. Meyerding and George A. Pollock. *The Military Surgeon*, LXXXVI, 593, June 1940.

These writers describe the symptoms, physical findings, roentgenograms, and treatment of march foot. They believe that overloading a foot already weakened functionally

and anatomically, is the most plausible theory of causation. The condition occurs during long marches when the foot is excessively fatigued. They describe the hair-line character of the fracture seen in the roentgenogram, and caution against overlooking it. When seen late, the lesion may resemble a tumor in the roentgenogram, and then a biopsy is required for diagnosis. Immobilization in plaster is the treatment recommended.—*Frank Kugler, M.D., Iowa City, Iowa.*

Die Deutung des Kahnsbeinspaltes im Wandel der Zeiten (Changing Interpretation of the Scaphoid Fissure). Fritz Reckling. *Beihefte zur Monatsschrift für Unfallheilkunde und Versicherungsmedizin*, Hefte 29, 1940.

The author reviews the various theories which have been advanced to explain the appearance of the fissure in the carpal scaphoid. This condition was first seen and described in 1865 by Gruber who considered the bipartite scaphoid to be a developmental arrest. Pfitzner considered it a reversion to an old condition of separation between the "ulnar scaphoid" and the "radial scaphoid". Still others are inclined to consider the bipartite condition as a pseudarthrosis, resulting from injury.

A lengthy discussion of the relative merits of each theory, with references for and against each, is presented. A critique of diagnostic procedures is suggested, but at the end the question still remains unanswered.—*Henry Milch, M.D., New York, N. Y.*

Contributo alla terapia della osteodistrofia fibrosa circoscritta (Contribution to the Treatment of Localized Osteitis Fibrosa Cystica). R. Memmi. *Ortopedia e traumatologia dell'apparato motore*, XI, 1, 1939.

The author reports twenty cases of the localized type of osteitis fibrosa cystica which obviously is divorced entirely from the generalized form. The condition was brought to light by a pathological fracture. He has seen cases with only partial healing of the lesion after the initial fracture, have complete healing after a second fracture occurred. After a fracture, the fibrous tissue ossifies by metaplasia in a manner analogous to the healing of fractures by callus. The healing after fracture was observed to last from three to six years. In two cases a progression of the lesion, instead of healing, took place. The author's observations disagree with those of Tavernier who feels that fracture has no favorable influence on localized osteitis fibrosa cystica. If fracture does not aid healing in such cases, the author feels that in spite of roentgenographic indications the histology of the lesion may be quite different from a localized osteitis fibrosa cystica. He states that, of course, giant-cell tumors are quite different, and are not benefited by a pathological fracture.

There seems to be no unanimity of opinion regarding treatment. The general tendency is toward open operation, though spontaneous healing has occurred on rare occasions. Geschickter and Copeland recently advocated fracturing the bone to produce healing, but the author argued that there was no point in scraping out these cavities which contain osteogenetic tissue. He, therefore, employed multiple perforations into the tumor. Perforations repeated after thirty to forty days gave clinical proof of improvement by the increased resistance of the tissue.

He obtained complete healing by this method in five cases, three of which had been treated unsuccessfully by curettage, bone graft, parathyroidectomy, and packing with chalk and iodoform, and feels that perforation of the cyst may become the method of choice in treating this lesion.—*A. W. Ciani, M.D., Iowa City, Iowa.*

La cura chirurgica della tubercolosi di spalla (The Surgical Treatment of Tuberculosis of the Shoulder). F. Mandruzzato. *Ortopedia e traumatologia dell'apparato motore*, XI, 53, 1939.

The author presents the indications and technique for resection and arthrodesis of the tuberculous shoulder. He favors resection wherever possible, and reserves arthro-

desis for cases which are so benign that resection might be considered too radical, or in which, after the disease is quiescent, painful incongruity of the shoulder joint or tension on the brachial plexus is present. Extra-articular arthrodesis is employed when there is danger of interfering with growth, when it is difficult to remove all the diseased bone, or when there is doubt that the quiescent stage has been reached.

The technique of resection is described. A total synovectomy is performed. A groove is made in the greater tuberosity, and the acromion, after its lower half has been resected, is imbedded in it. The patient is kept in a shoulder spica for six to eight months, and later in a celluloid splint at night.

For arthrodesis the author follows the technique of Delitala which, together with resection of the joint surfaces, may be used for a combined intra-articular and extra-articular fusion.

Of the fifteen cases reported, one-half of which were between the ages of twenty and thirty years; seven were resections, five combined intra-articular and extra-articular fusions, and three were extra-articular fusions.

Twelve patients were followed for from two to nine years. All had complete relief from pain and, with one exception, complete bony ankylosis. This one patient had no pain and a firm fibrous ankylosis which was recognized only in the roentgenogram. All patients were able to return to their former work, some doing heavy labor, without difficulty.

Of the other three, two had been operated on too recently to be reported, and one had died of miliary tuberculosis in six months.

The optimum position was 80 degrees abduction with 25 degrees forward flexion.

In view of the excellent results the author strongly favors the surgical over the conservative treatment of the condition.—*A. W. Ciani, M.D., Iowa City, Iowa.*

RESULTS OF CLOSED REDUCTION OF CONGENITAL DISLOCATION OF THE HIP. R. Memmi. *Ortopedia e traumatologia dell'apparato motore*, XI, Apr. 1939.

The author reports ninety-eight cases treated by closed reduction and followed for from two to thirteen years. The Paci-Lorenz manoeuvre was employed and the hips kept in the primary position for from two to five months, and in the secondary position one and a half to four months, with about three to four weeks in the intermediate position.

The difference between the two sexes was very marked; eighty-six were females and twelve were males.

Fifty per cent. gave immediate good results, 33.67 per cent. fair, and 16 per cent. poor results. A large proportion of the immediate good results, and smaller proportions of the fair and poor results were in patients under the age of three years. Of the long-range results half were still good, but some of the immediate fair results became poor. About 80 per cent. of the patients over the age of five years gave poor results, and the author feels that the use of closed reduction is too great a risk in these cases.

A small group of patients with immediate good results showed a tendency toward coxa plana and later had mediocre results; but a small group, under the age of three years, with immediate mediocre results, had subchondral lesions which eventually healed, and later showed good results. The patients with early mediocre results and later poor results were those with a coxa vara or insufficient regeneration of the acetabulum, and an incongruity of the head, who were treated after the age of three years. In the patients of this group, totalling 10 per cent., redislocations or degenerative arthritis developed. The vast majority of cases of coxa valga and coxa plana occurred in patients under three years of age, whereas most of the arthritis and coxa vara cases were found in patients over that age.

The results in unilateral cases were 20 per cent. better than in the double dislocations, in both the early and long-range statistics.

The author's results indicated a direct relation between the severity of the dislocation and the possibility of a good result. He found that a five-year follow-up is the minimum for an accurate prognosis.

His criteria for good results are absence of pain and limp, complete range of hip motion in all directions, good morphology of the head and acetabulum, and normal relation of the components of the hip joint. A slight flattening of the femoral head is permissible if the other requirements are met. Mediocre results are indicated by easy fatigability and pain on weight-bearing, a diminution of the range of motion, and degenerative changes in the head and acetabulum. In this group, varying degrees of coxa plana, underdevelopment or regression of the superior portion of the acetabulum, and coxa vara were found. The poor group included redislocations, degenerative arthritis resulting from profound morphological skeletal changes incompatible with free function, pain, contractures, marked interference with weight-bearing and gait.—*A. W. Ciani, M.D., Iowa City, Iowa.*

Sur Onze Observations de Tuberculose Sous-Astragalienne Chez l'Adulte Jeune (Eleven Cases of Subtalar Tuberculosis in the Young Adult). R. Dubau and F. Bolot. *La Presse Médicale*, XLVIII, 519, May 21, 1940.

Among thirty cases of tuberculosis of the foot, eleven involved the subtalar joint. The principles of diagnosis are discussed. Attention is called to the fact that in the presence of a subtalar arthritis, a positive sputum is presumptive evidence of the tuberculous nature of the disease. The authors point out that the subtalar joint consists of two parts, which are completely separated by the tarsal ligament of Farabeuf. The anterior portion of the subtalar joint is usually in connection with the midtarsal joint. The posterior portion occasionally communicates with the ankle joint, but infection in this joint is usually by contiguity. Isolated infection of the posterior part of the joint may occur. Isolated infection of the anterior subtalar joint is impossible. The prognosis is good, except when the Chopart joint is involved.

The treatment is of the accepted type. A simple means of fusing the subtalar joint by driving a bone graft through both talus and os calcis is illustrated.—*Henry Milch, M.D., New York, N. Y.*

Hand-Schüller-Christian Syndrome. P. E. Thompson Hancock. *Proceedings, Royal Society of Medicine*, XXXII, 1386, 1939.

Case report of a female, age eighteen, with a history of a spontaneous fracture of the upper end of the left humerus at the age of three, associated with previous ill health. There was generalized lymphadenopathy. Operative procedure disclosed a yellow gelatinous growth at the site of fracture. A bone graft was done. At the age of six years two tumors appeared in the skull which were treated with radium. Four years later further skull tumors developed in the frontal and parietal regions. These also were treated with radium. At the age of eleven, there was a spontaneous fracture of the right femur. X-rays at Royal Cancer Hospital in 1934, eleven years after onset, suggested Hand-Schüller-Christian's syndrome with areas of rarefaction in the skull and a cyst in the neck of the right femur. Blood phosphorus, calcium, and sugar were normal. Blood cholesterol was 189 milligrams. Patient was given high-voltage therapy. In 1937 she developed slight proptosis of both eyes, inequality of pupils, left facial palsy, bilateral nerve deafness, and atrophy of the right half of the tongue. Her mental condition was good. There were no symptoms of diabetes insipidus. The family history was negative. On examination there was a flail left arm, torticollis, and marked scoliosis. Patient was able to walk.—*S. Albert, M.D., Iowa City, Iowa.*

Paget's Disease With Paraplegia. J. St. C. Elkington. *Proceedings, Royal Society of Medicine*, XXXII, 1420, 1939.

Case report of a seventy-year-old man with history of gradually increasing weakness of both legs, especially the right; numbness, beginning in feet and gradually spreading up to the umbilicus. Increasing constipation and difficulty in voiding were noted.

Examination revealed no obvious bony deformity. There was moderate spasticity of both legs with corresponding weakness of flexor muscles, and some wasting of the quadriceps bilaterally. Abdominal reflexes were absent; knee jerks, accentuated, and ankle jerks, absent. There was a bilateral Babinski. All forms of cutaneous sensibility were diminished in the lower extremities and the lower part of the trunk. X-rays of the skull, spine, and pelvis showed the advanced changes of Paget's disease.

Of two previous cases of Paget's disease seen by the author, both of which involved the cord, one responded quickly to laminectomy; the other, not at all.—*S. Albert, M.D., Iowa City, Iowa.*

SYNOVECTOMY OF THE KNEE JOINT. F. Walter Carruthers. *Southern Medical Journal*, XXXIII, 550, May 1940.

This is a report of thirty-four synovectomies performed for two cases of chronic hypertrophic villous arthritis; four of chronic arthritis; eight of chronic synovitis; and fourteen of chronic infectious arthritis. Six were bilateral. Ages ranged from eighteen to sixty-nine years. Wounds were closed. No fixation except a simple Buck's extension was used for the first ten days. At the end of six weeks the patients were usually up and walking with the aid of a cane or crutches. Heat and light massage were used in the convalescent period. More than ninety-five per cent. of the cases were relieved. End results showed: twenty-two very satisfactory, two fair, six improved. Four became ankylosed but were relieved of pain.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

THE ROENTGENOLOGIC BONE MANIFESTATIONS IN CERTAIN GENERALIZED DISEASES OF INFANTS AND CHILDREN. W. D. Anderson and James G. Hughes. *Southern Medical Journal*, XXXIII, 660, June 1940.

The material in this article is classified under five headings: (1) congenital anomalies which include Albers-Schönberg disease (osteopetrosis or marble bones), osteogenesis imperfecta (fragilitas ossium), and chondrodystrophia foetalis (achondroplasia); (2) infections, limited to syphilis; (3) endocrine disturbances; (4) metabolic disturbances which include rickets, scurvy, and xanthomatosis (Hand-Schüller-Christian syndrome and chronic Gaucher's disease); (5) changes due to chemicals such as lead, phosphorus, bismuth; and (6) anaemias which cover sickle-cell anaemia and erythroblastic anaemia.

Roentegenograms of the long bones often give helpful hints in the diagnosis of these conditions.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

DIAGNÓSTICO RADIOGRÁFICO DEL MAL DE POTT DORSOLUMBAR (The Roentgenographic Diagnosis of Dorsolumbar Pott's Disease). Carlos E. Ottolenghi. *Revista de Ortopedia y Traumatología*, VIII, 394, 1939.

In the diagnosis of dorsolumbar Pott's disease, the author emphasizes the following points which are all brought out in the roentgenograms: the early appearance of the lesion, spondylitic scoliosis, narrowing of the intervertebral disc, herniation of the disc into the body of the vertebra, central lesion with collapse, multiple and irregular foci, mediastinal abscess, extended destructive lesion with angulation, and diffuse lesions extending over several vertebrae.

For differential diagnosis, dorsolumbar Pott's disease is contrasted with vertebral epiphysitis, metastases of diffuse carcinomatosis of the vertebrae, tabetic arthropathies, hemivertebrae, and particularly the osteomyelitis and infectious spondylitis with osteophytic periosteal reaction.

In one case of Pott's disease the author demonstrates the central cavity of the vertebral body, which had not changed its normal form and showed only the presence of the large carious zone in its interior. In another form the disease is localized in the posterior arches. In the roentgenogram this is seen as loss of substance at the level of the lamina and pedicle, similar to that observed in cases after a hemilaminectomy.

His varied material demonstrates the polymorphous character of tuberculosis.
—*Arthur Steindler, M.D., Iowa City, Iowa.*

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